

AC-A088 220

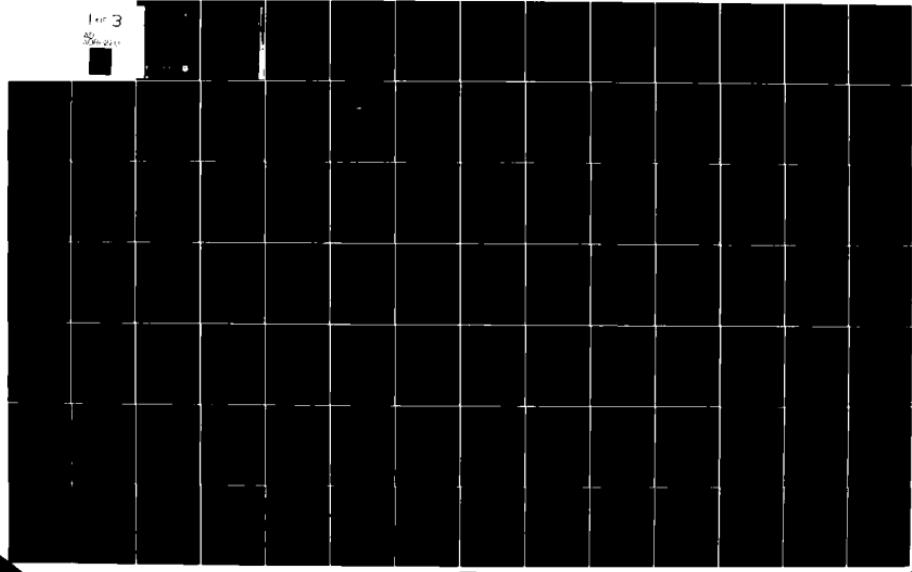
AIR FORCE GEOPHYSICS LAB HANSCOM AFB MA
AN ATLAS OF SELECTED MULTI-FREQUENCY RADIO BURSTS FROM THE TWEN--ETC(U)
APR 80 W R BARRON, V L BADILLO, E W CLIVER
UNCLASSIFIED AFGL-TR-80-0098

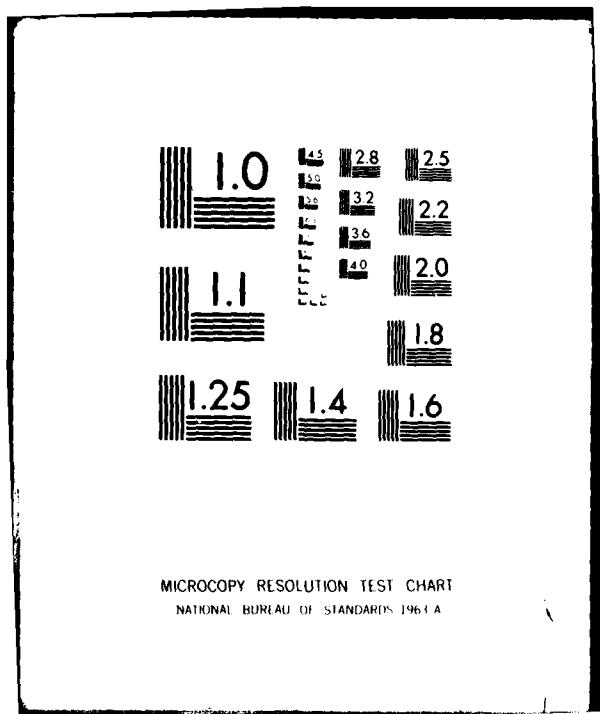
F/B 3/2

NL

Fig 3

AFGL-TR-80-0098





LEVEL

AFGL-TR-80-0098
ENVIRONMENTAL RESEARCH PAPER NO. 100

200
An Atlas of Selected Shallow Groundwater
Reactive Bursts From 1970-1979 in the Great Lakes

WILLIAM A. BURGESS
EDWARD V. COOK
DONALD A. GIBSON
VIRGINIA R. RUMBLE

24

ADA088200

This report has been reviewed by the [redacted] and is determined to be releasable to the National Technical Information Service.

This technical report is approved for public release.

FOR THE CHIEF



Chief

Qualified
Director of
National

(14) AFGL-TR-88-0098
AFGL-ERP-699

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(9) Environmental research paper

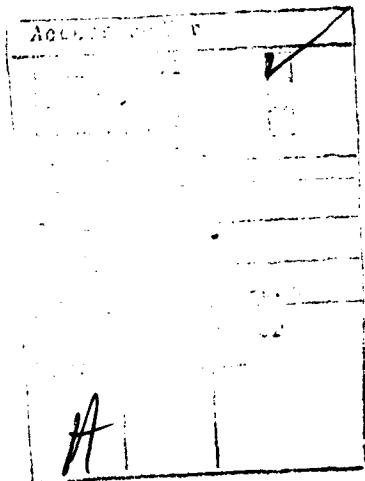
REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. TITLE (If Different from Block 1) AN ATLAS OF SELECTED MULTI-FREQUENCY RADIO BURSTS FROM THE TWENTIETH SOLAR CYCLE		2. GOVT ACCESSION NO. AD-A088224	
4. LINES OF SUBMITTER William R. Barron Victor L. Badillo S.J.* Edward W. Cliver Donald A. Guidice		3. RECIPIENT'S CATALOG NUMBER	
5. TYPE OF REPORT & PERIOD COVERED Scientific. Interim.		6. PERFORMING ORG. REPORT NUMBER	
7. CONTRACT OR GRANT NUMBER(S)		(17) 03	
8. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Geophysics Laboratory (PHP) Hanscom AFB Massachusetts 01731		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBER 62101F 46430306	
9. CONTROLLING OFFICE NAME AND ADDRESS Air Force Geophysics Laboratory (PHP) Hanscom AFB Massachusetts 01731		11. REPORT DATE 2 Apr 80	
12. NUMBER OF PAGES 247		13. SECURITY CLASS. (of this report)	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12/228		15. SECURITY CLASS. (of this report) Unclassified	
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		15a. DECLASSIFICATION DOWNGRADING SCHEDULE	
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES * Manila Observatory, The Philippines			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Solar radio bursts Proton events Non-U solar bursts Solar radio spectra Radio burst temporal evolution			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Illustrations or reconstructions of the analog records of significant and interesting solar radio bursts observed during Solar Cycle 20 at the AFGL Sagamore Hill Radio Observatory in Hamilton, Massachusetts, and the Manila Observatory in the Philippines are presented. Many of the illustrated burst records were associated with the emission of energetic solar protons and subsequent disturbances to the ionosphere and the geomagnetic field.			

DD FORM 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

4095787 fm



Contents

SOLAR RADIO BURSTS - 1965	7
SOLAR RADIO BURSTS - 1966	11
SOLAR RADIO BURSTS - 1967	29
SOLAR RADIO BURSTS - 1968	47
SOLAR RADIO BURSTS - 1969	81
SOLAR RADIO BURSTS - 1970	109
SOLAR RADIO BURSTS - 1971	135
SOLAR RADIO BURSTS - 1972	159
SOLAR RADIO BURSTS - 1973	191
SOLAR RADIO BURSTS - 1974	213
SOLAR RADIO BURSTS - 1975	231
SOLAR RADIO BURSTS - 1976	235
SOLAR RADIO BURSTS - 1977	241

An Atlas of Selected Multi-Frequency Radio Bursts From the Twentieth Solar Cycle

William R. Barron
Edward W. Cliver
Donald A. Guidice
Air Force Geophysics Laboratory
Hanscom AFB, MA 01731

Victor L. Badillo, S. J.
Manila Observatory, Philippines

Multi-frequency patrol observations of the radio sun are now well into their fourth solar cycle. The radiometer systems used to observe solar radio emissions are in their second generation, and shortly the familiar strip chart records will give way to cathode ray tube displays and magnetic tape recordings. At this juncture we thought it would be useful to gather in one place a collection of illustrations of some of the outstanding multi-frequency solar radio events of solar cycle 20 as observed by the AFGL Sagamore Hill Radio Observatory and the Manila Observatory.

This report is not intended as a comprehensive atlas of all solar radio bursts observed by the two observatories. A majority of the bursts associated with flares having significant geophysical effects are included. The remainder of the burst illustrations are mainly ones which it was felt had some interesting characteristic(s) associated either with the temporal variation of the burst flux level or with the spectral character of the burst. Many of these burst illustrations have been

(Received for publication 1 April 1980)

reproduced elsewhere, either in Solar-Geophysical Data or in the open literature. Others have not. The early less polished burst illustrations have been included here to maintain the historical continuity of the observations.

The information obtained from the analysis of the burst data illustrated here has been used to assist in the derivation of algorithms predictive of flare-induced geophysical disturbances. The radio burst profiles have also been correlated with flare emissions at other wavelengths to provide an improved understanding of the flare phenomenon. The material in this atlas has been assembled as a contribution to further advances in the study of solar flares and their interplanetary and terrestrial effects.

Over the years, the solar ratio program conducted by the Air Force Geophysics Laboratory (previously AFCRL) has benefited from the efforts of many individuals. We give blanket acknowledgement to the men and women of the Air Weather Service who have manned the Sagamore Hill Solar Radio Observatory since its inception. This atlas would not have been possible without the dedicated effort of Mr. John P. Castelli, former Chief of the Solar Radio Section of AFGL, and the continuing support of Dr. Jules Aarons, Chief of the Trans-Ionospheric Propagation Branch of AFGL. The Sagamore Hill burst illustrations were produced by SMSgt. Art Francis and TSgt. Dick Rickard.

NOTES ABOUT THE ILLUSTRATIONS

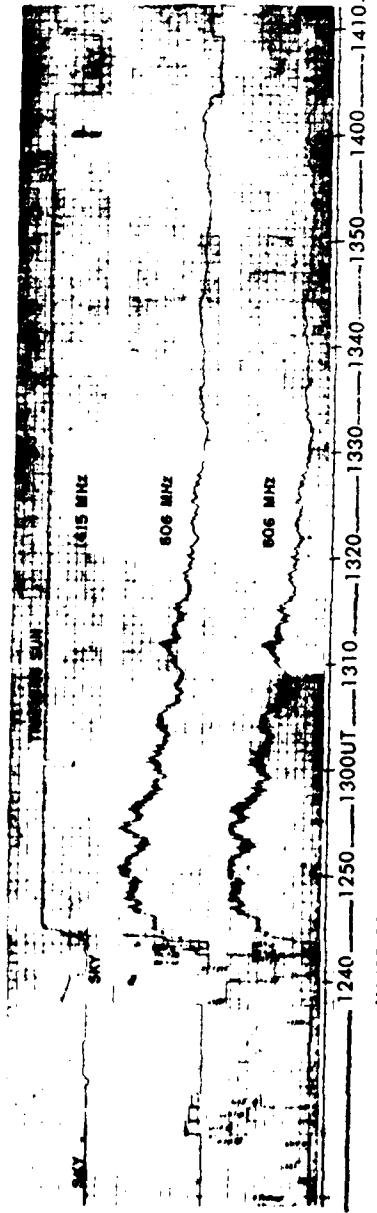
The time flow in most of the illustrations is from right → left, however a few of the illustrations have time running from left → right, so care should be exercised in reading the illustration time scales.

The amplitude scales in all of the illustrations are linear, except for 28 August 1966, 23 May 1967, and 29 October 1968 (two illustrations), which are logarithmic.

In some burst illustrations there are two adjacent lines at the same frequency with different amplitude scale factors, and in a few other cases the line of the analog trace is broken at a particular flux level and then picked up at a higher flux level to keep the illustration itself within reasonable dimensional bounds. This line break has been accomplished to produce as little loss of burst detail as possible.

Most of the illustrations given here are reconstructions of the original analog records. If more detail of a record is needed, the reporting observatory will answer reasonable requests for copies of the original analog records.

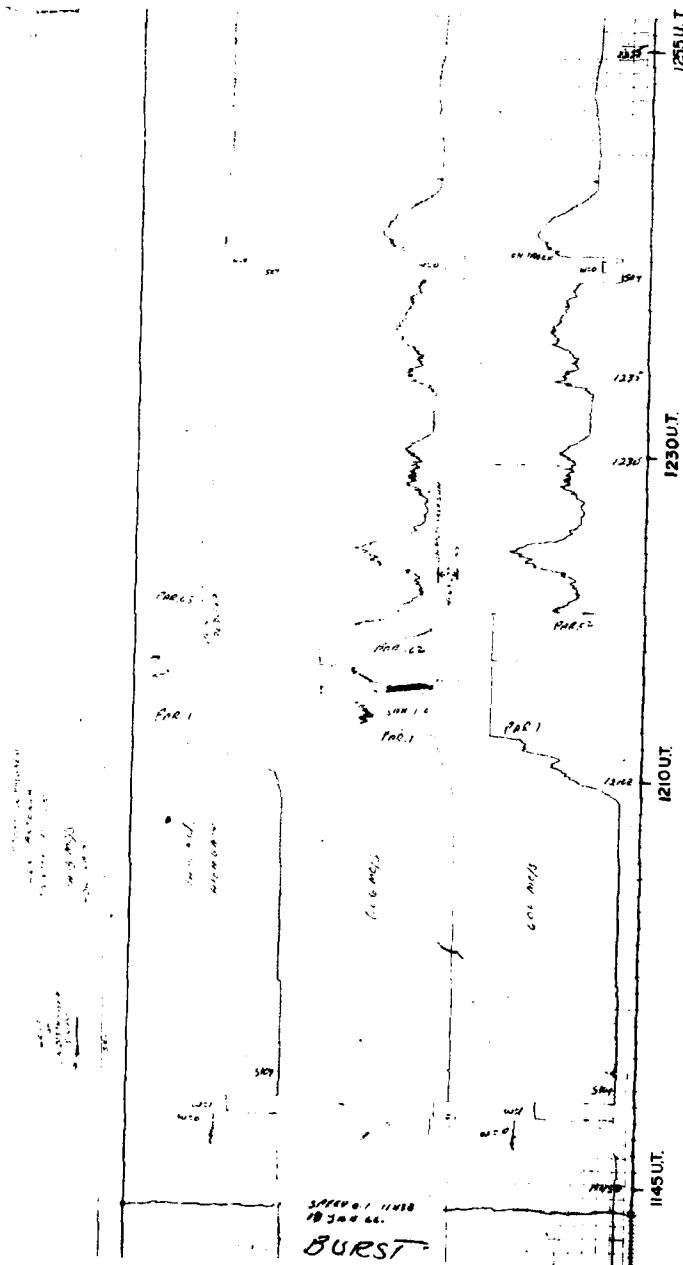
**Solar Radio Bursts
1965**



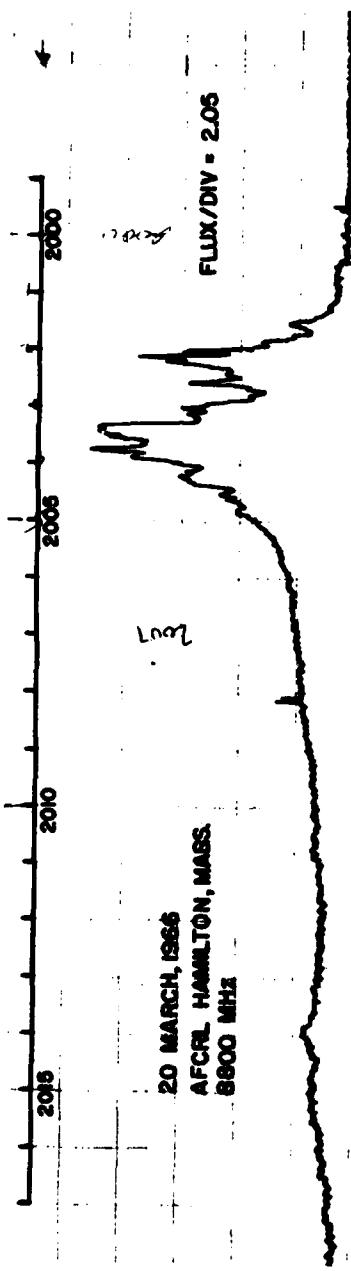
MAJOR SOLAR EVENT IN PROGRESS ON 606 MHz 4 OCTOBER 1965 WHEN DAILY OBSERVATIONS BEGAN.
PEAK FLUX = APPROXIMATELY 40 x FLUX OF 3 OCTOBER 1965. NO INCREASE ON 1415 MHz NOTED.

**Solar Radio Bursts
1966**

~~Engineering~~ PAGE BLANK-NOT FILMED

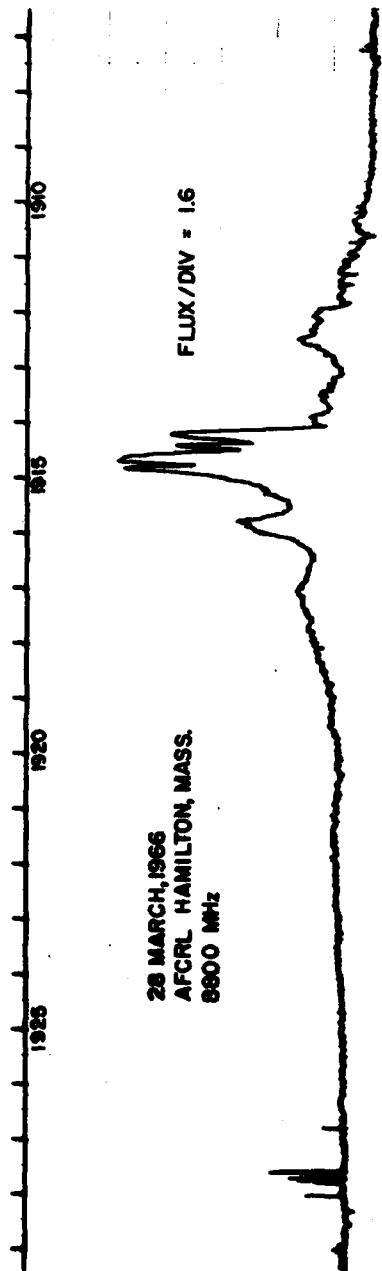


SOLAR RADIO BURST OBSERVED 17 JANUARY 1966 AT
SAGAMORE HILL RADIO OBSERVATORY

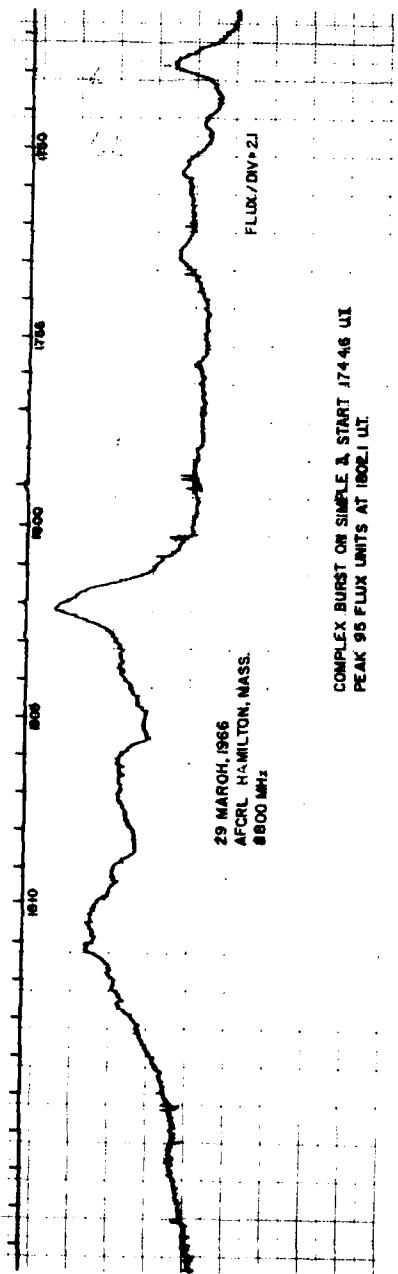


COMPLEX BURST WITH PB1, START 1959 UT

PEAK 91 FLUX UNITS AT 2003.8 UT

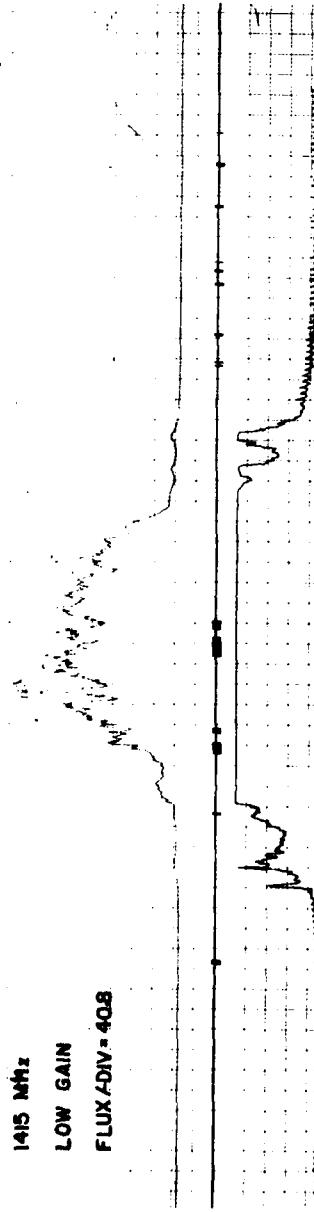


COMPLEX BURST WITH PB, START 1909.6 UT.
PEAK 72 FLUX UNITS AT 1914.6 UT



COMPLEX BURST ON SAMPLE A, START 17446 UT
PEAK 95 FLUX UNITS AT 1800 UT

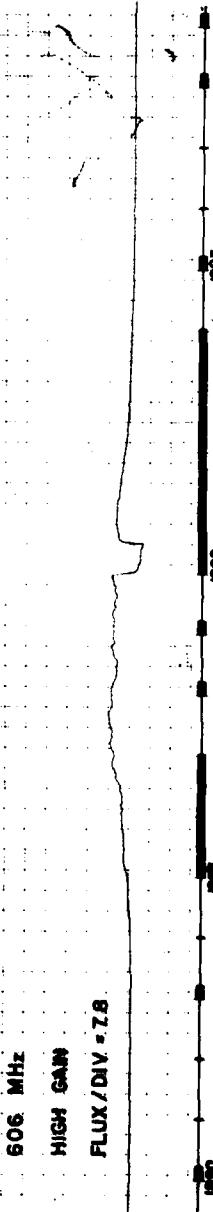
1415 MHz
LOW GAIN
FLUX/DIV = 40.8



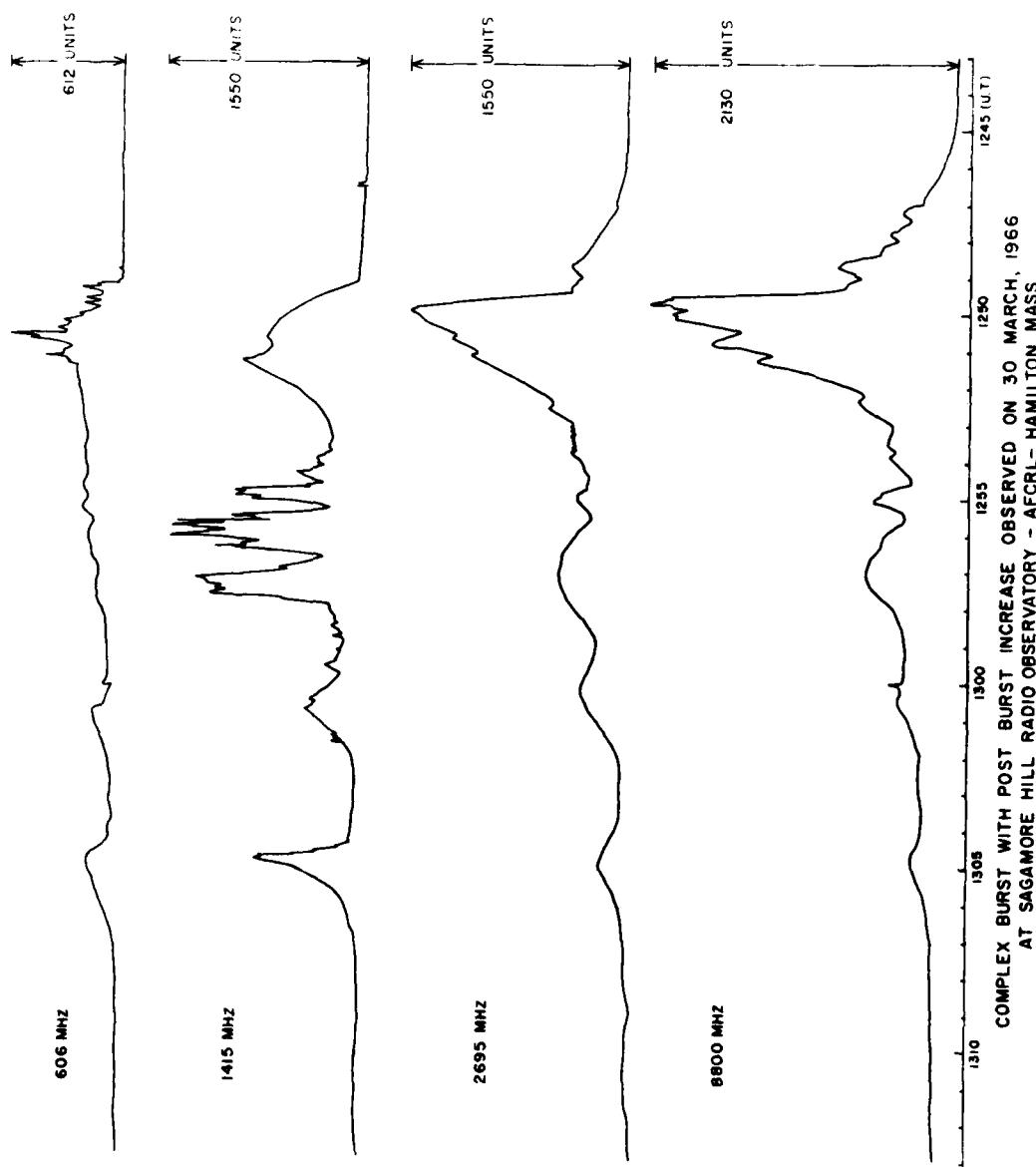
1415 MHz
HIGH GAIN
FLUX/DIV = 21.0
29 MARCH, 1966
AFCR, HAMILTON, MASS.
COMPLEX BURST WITH PB1

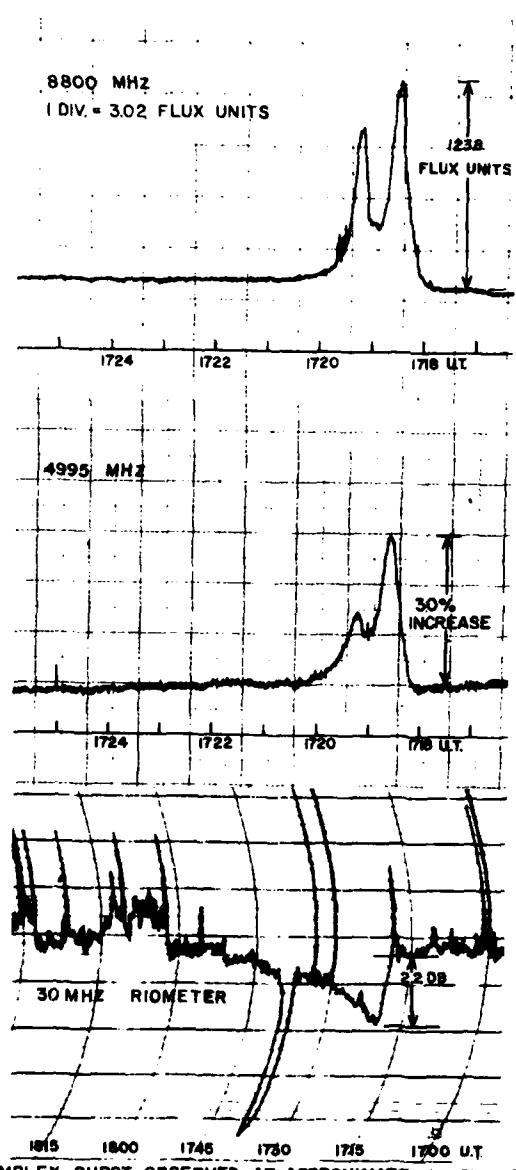


806 MHz
LOW GAIN
FLUX/DIV = 15.5

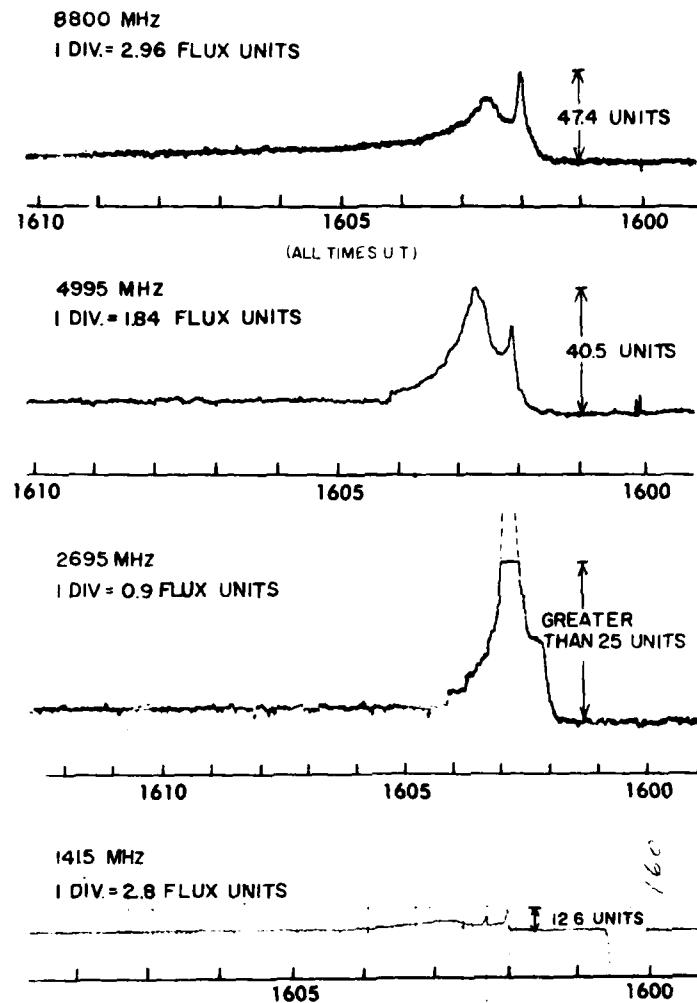


806 MHz
HIGH GAIN
FLUX/DIV = 7.9

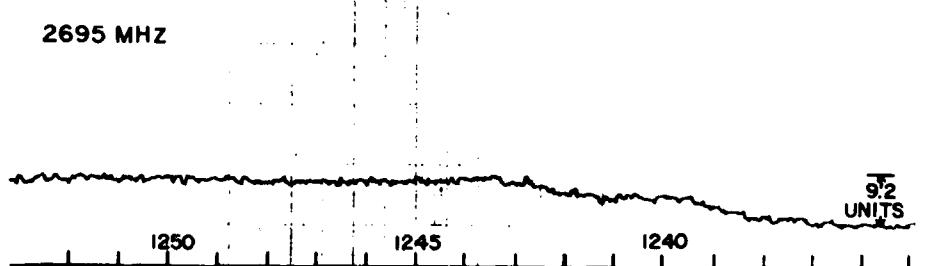
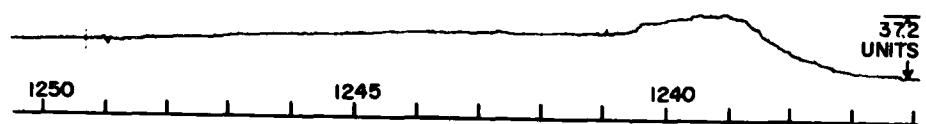
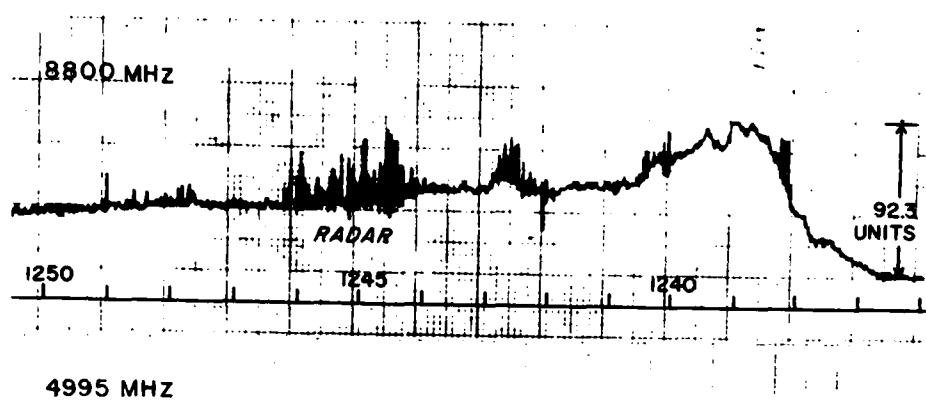




COMPLEX BURST OBSERVED AT APPROXIMATELY 1718 U.T.
APRIL 12, 1966 AT AFCRL HAMILTON, MASS.
NO SIGNIFICANT FLUX INCREASE OBSERVED AT 2695, 1415, OR 606 MHZ

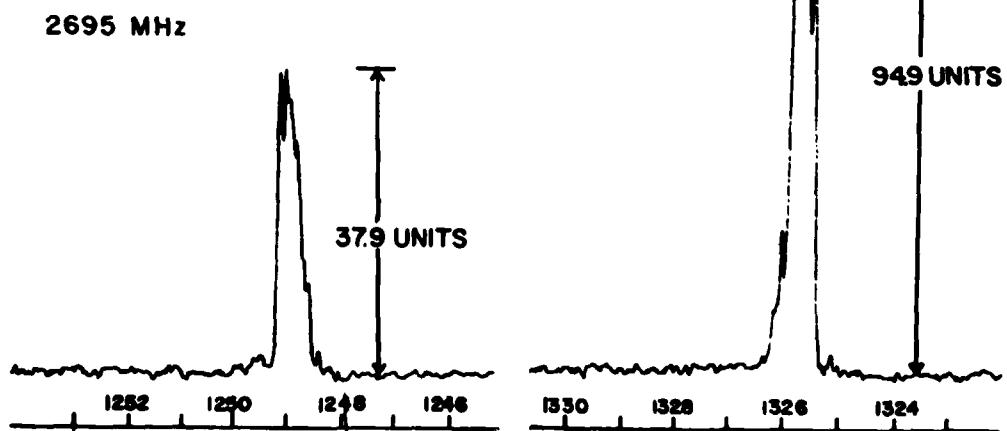
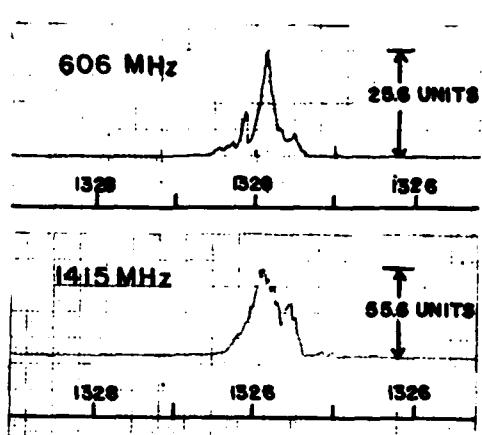
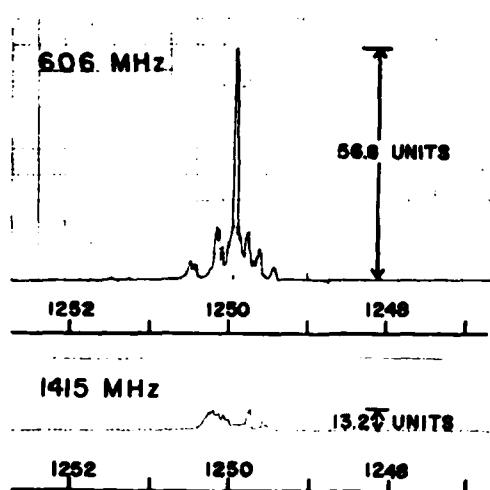


COMPLEX BURST WITH POST BURST INCREASE OBSERVED
AT APPROXIMATELY 1602 UT JUNE 12, 1966 AT SAGAMORE
HILL RADIO OBSERVATORY (AFCRL) — HAMILTON, MASS.
(NO FLUX INCREASE OBSERVED ON 606 MHZ)

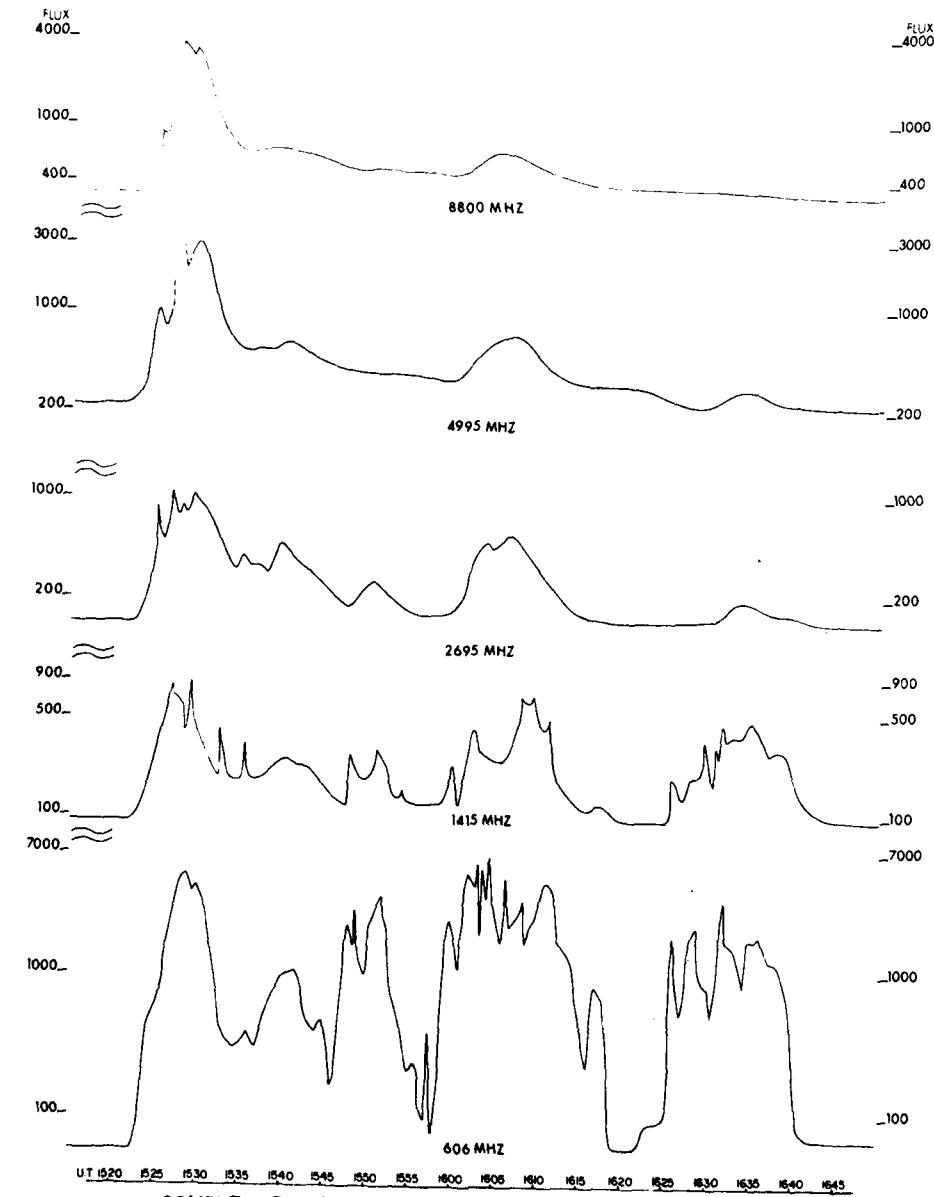


SIMPLE TWO BURST WITH POST BURST INCREASE OBSERVED AT APPROXIMATELY 1237 U.T. JULY 8, 1966 AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL)—HAMILTON, MASS.

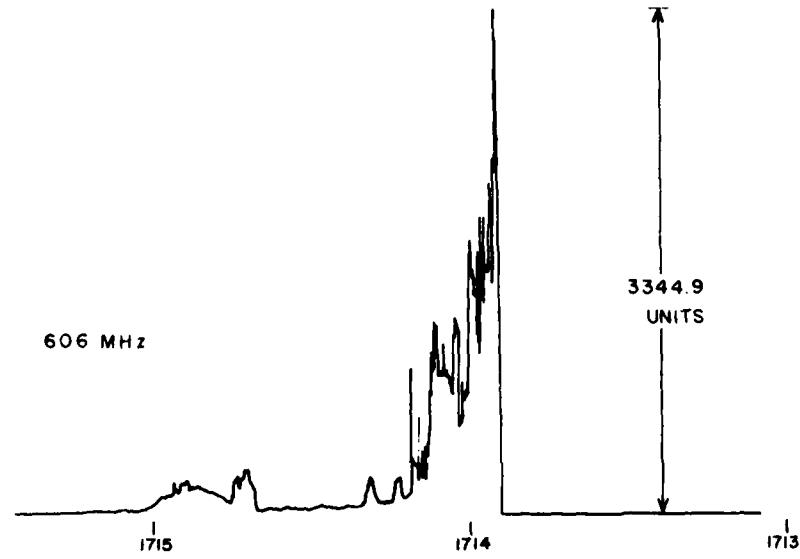
(SLIGHT FLUX INCREASES OBSERVED ON 1415 AND 606 MHZ)



TWO SIMPLE 2(f) BURSTS OBSERVED ON 17 JULY, 1966 AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL) HAMILTON, MASS. (NO FLUX INCREASE OBSERVED ON 4900 OR 8800 MHz... ALL TIMES ABOVE ARE U.T.)

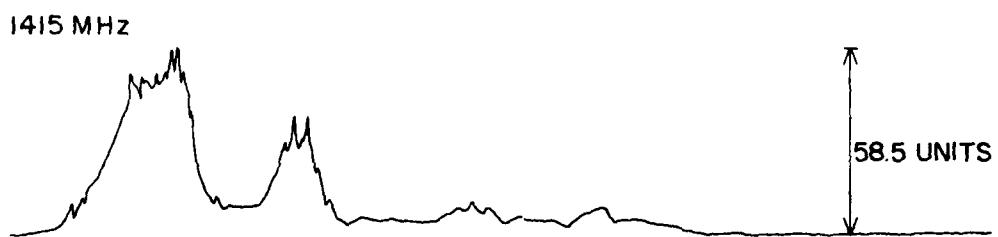


COMPLEX RADIO BURST OF THE SOLAR PROTON EVENT
28 AUGUST, 1966 SAGAMORE HILL RADIO OBSERVATORY (AFCRL) HAMILTON, MASS.



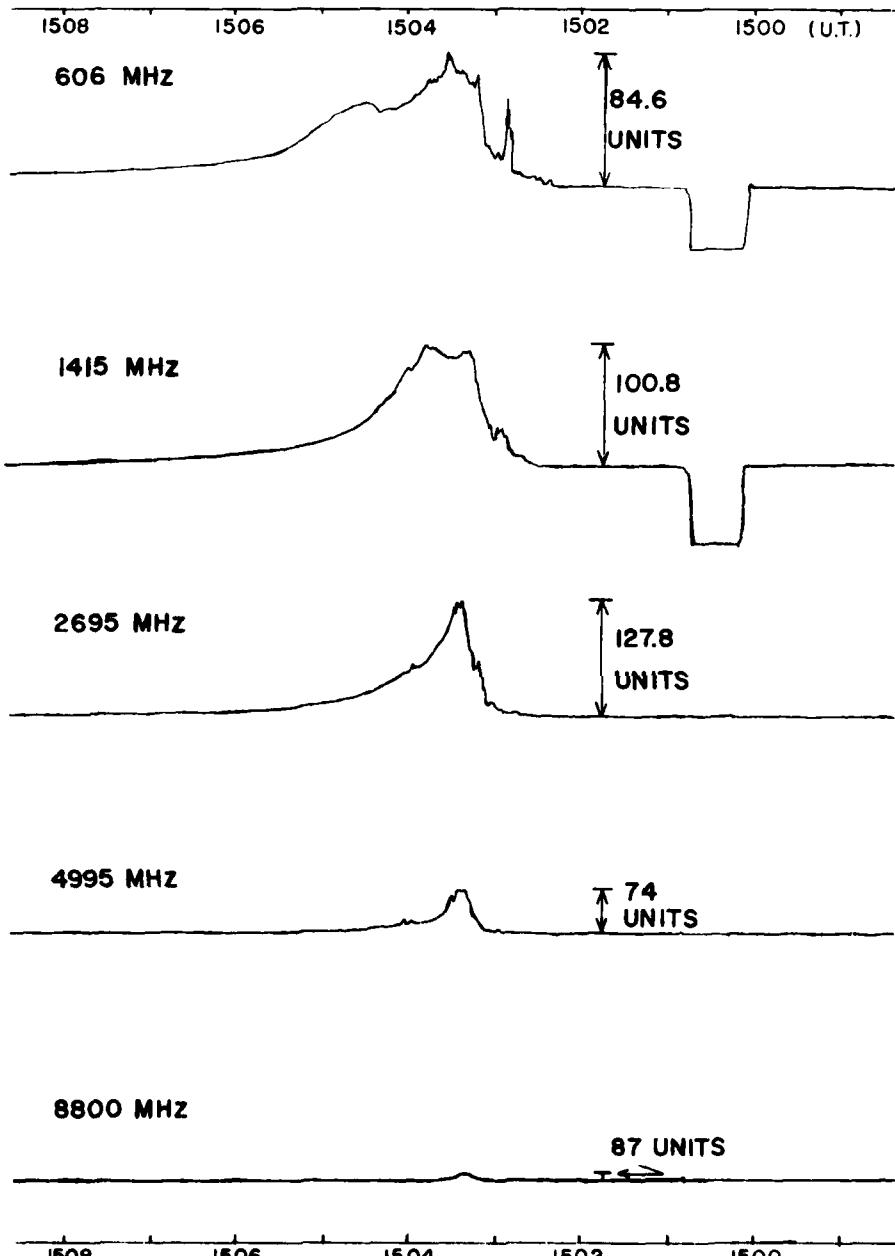
1715 (U.T.) 1714 1713
IMPULSIVE COMPLEX BURST OBSERVED ON 20 SEPTEMBER, 1966
SAGAMORE HILL RADIO OBSERVATORY (AFCRL) HAMILTON, MASS.

2044 2042 2040 2038 2036 2034 2032 (U.T.)

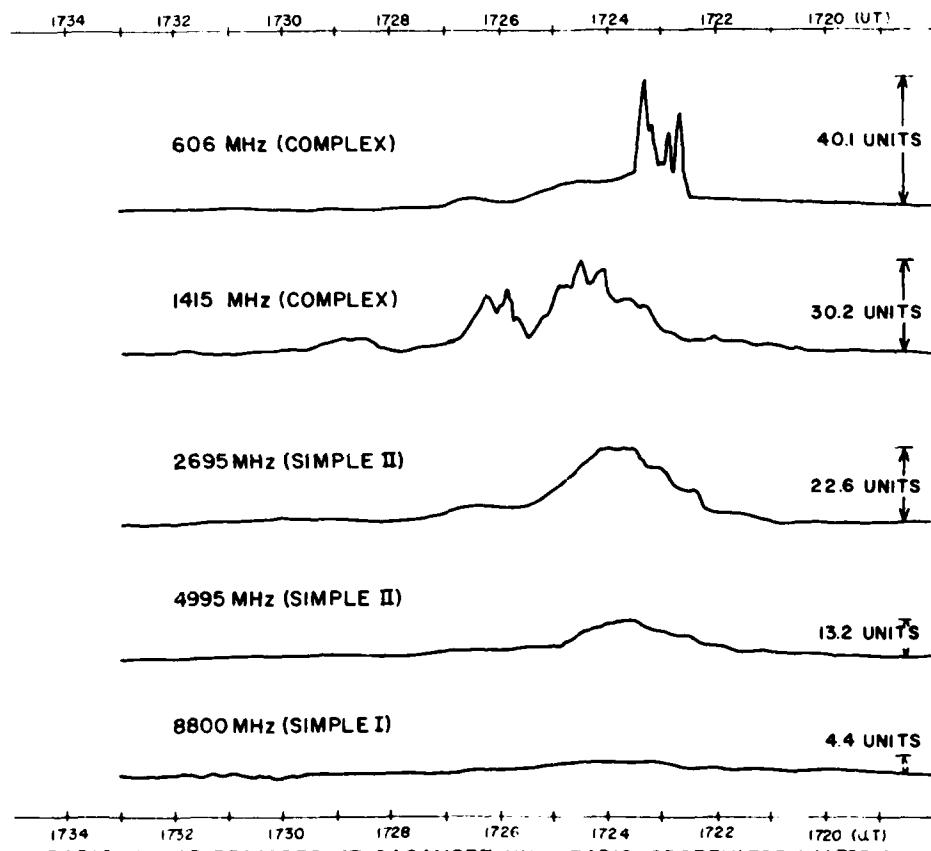


2044 2042 2040 2038 2036 2034 2032 (U.T.)

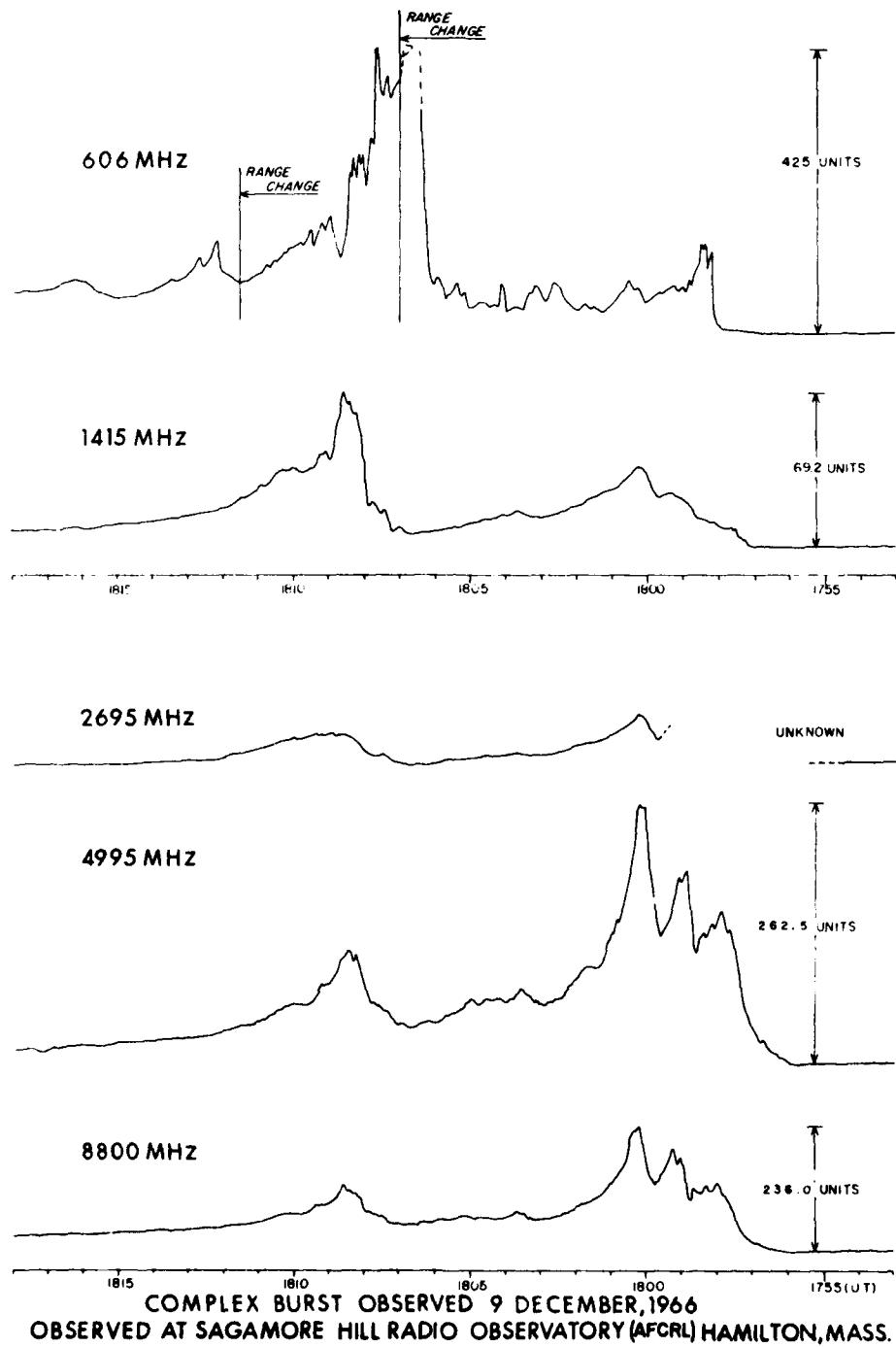
COMPLEX BURST OBSERVED 20 OCTOBER, 1966
AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL) HAMILTON, MASS.



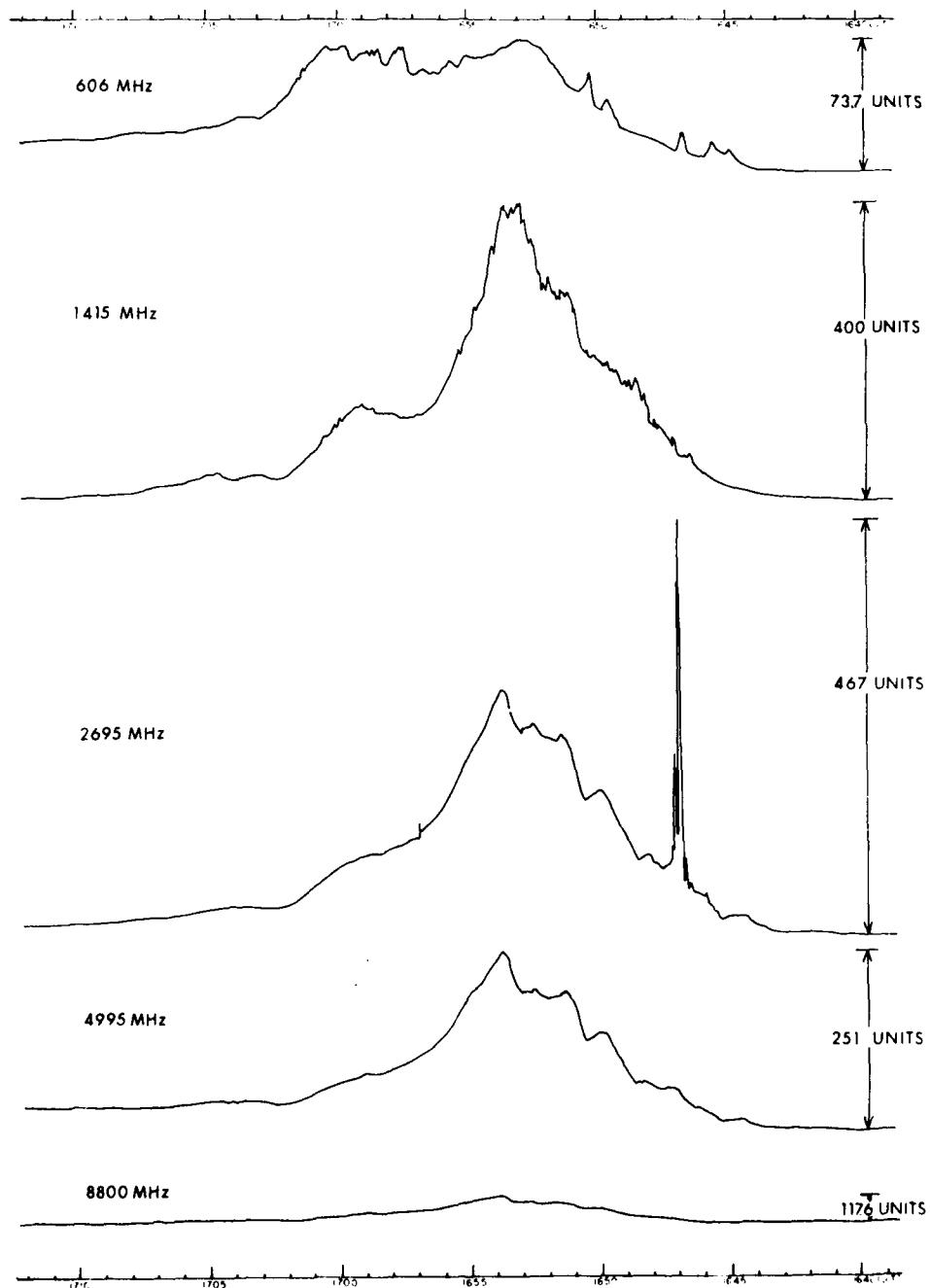
SIMPLE II BURST OBSERVED 24 OCTOBER, 1966
 AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL) HAMILTON, MASS.
 (NOTE: 606 MHz BURST IS COMPLEX)



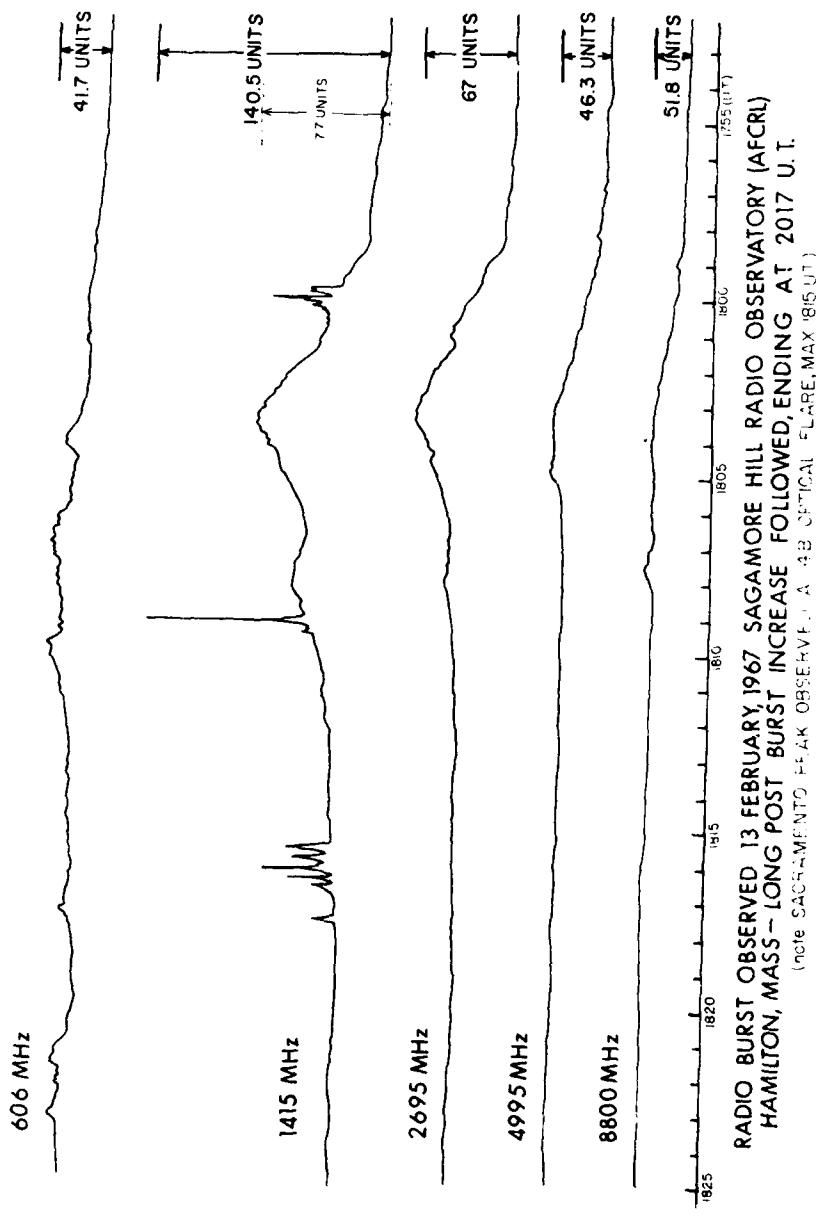
RADIO BURST RECORDED AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL)
HAMILTON, MASS. ON 2 NOVEMBER, 1966



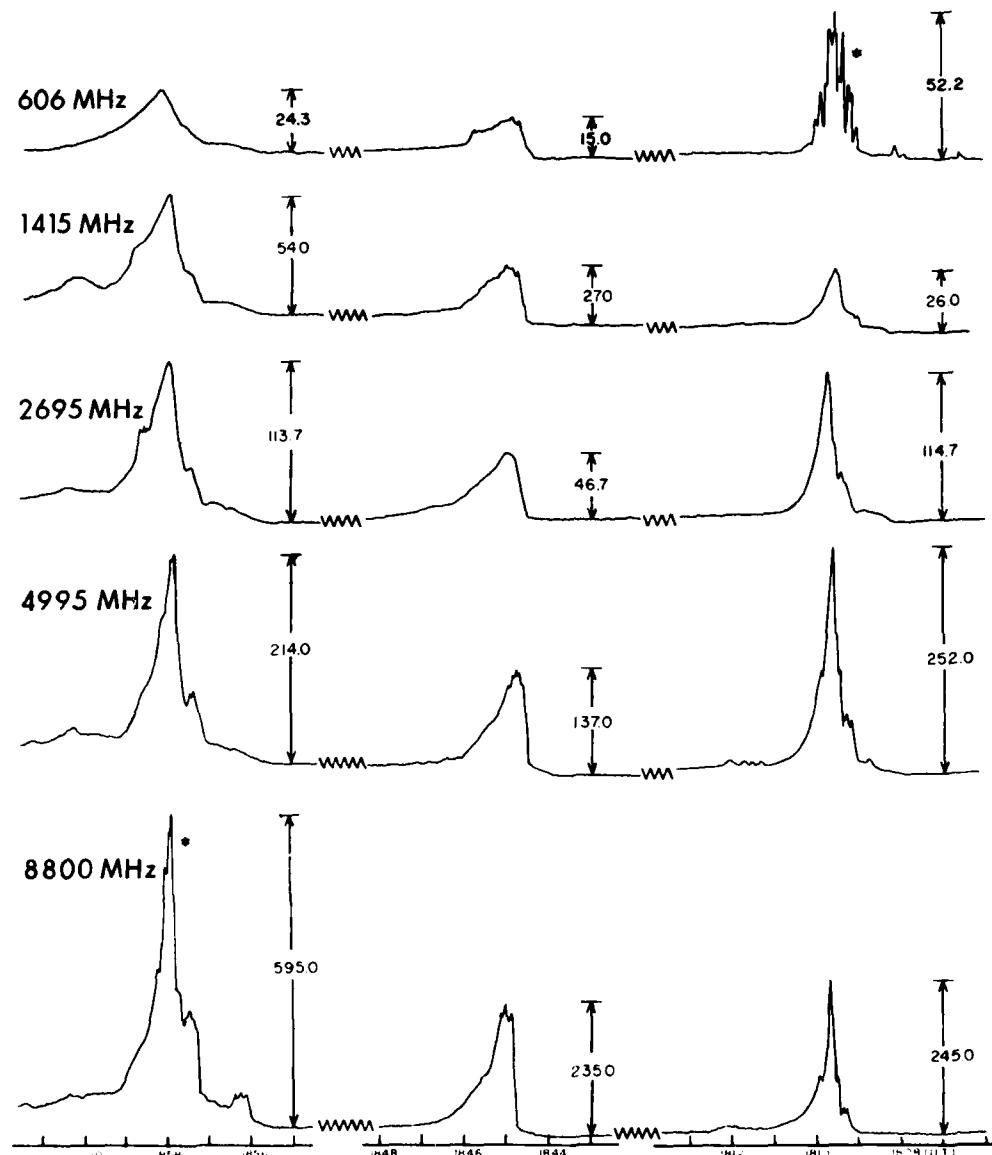
**Solar Radio Bursts
1967**

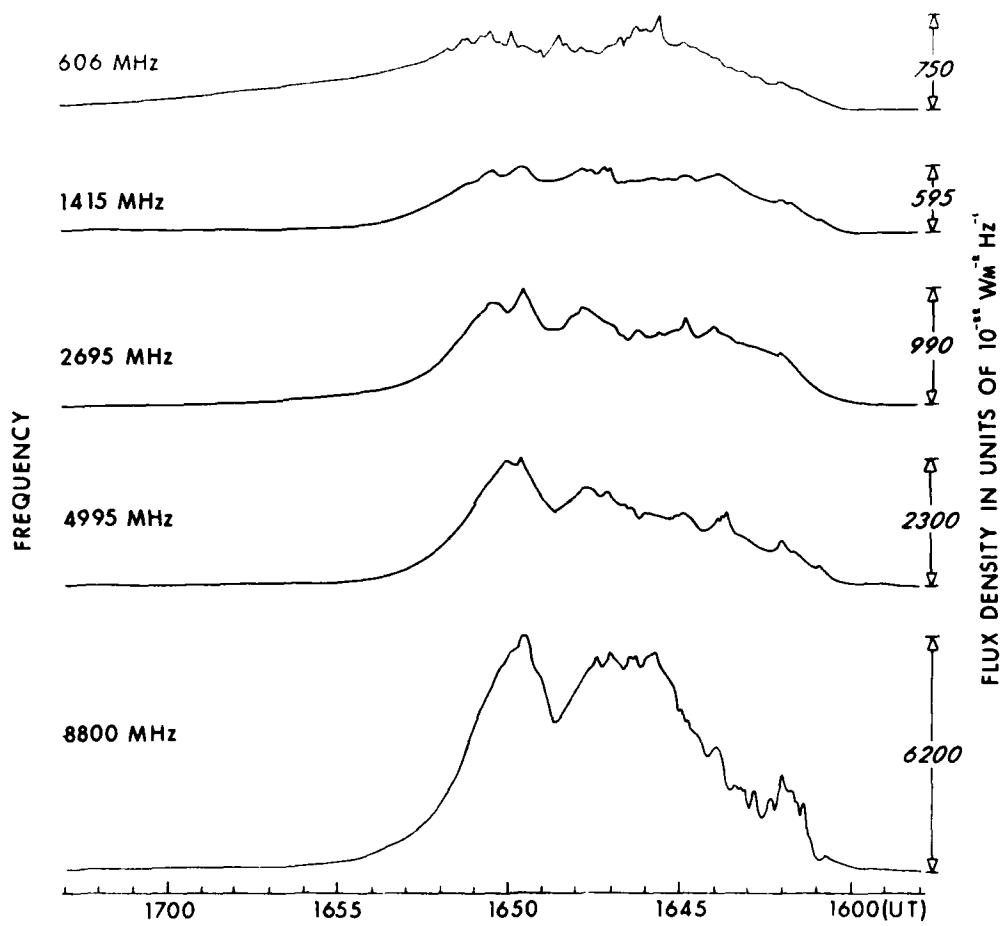


COMPLEX BURST OBSERVED 4 FEBRUARY, 1967
SAGAMORE HILL RADIO OBSERVATORY(AFCRL) HAMILTON, MASS.

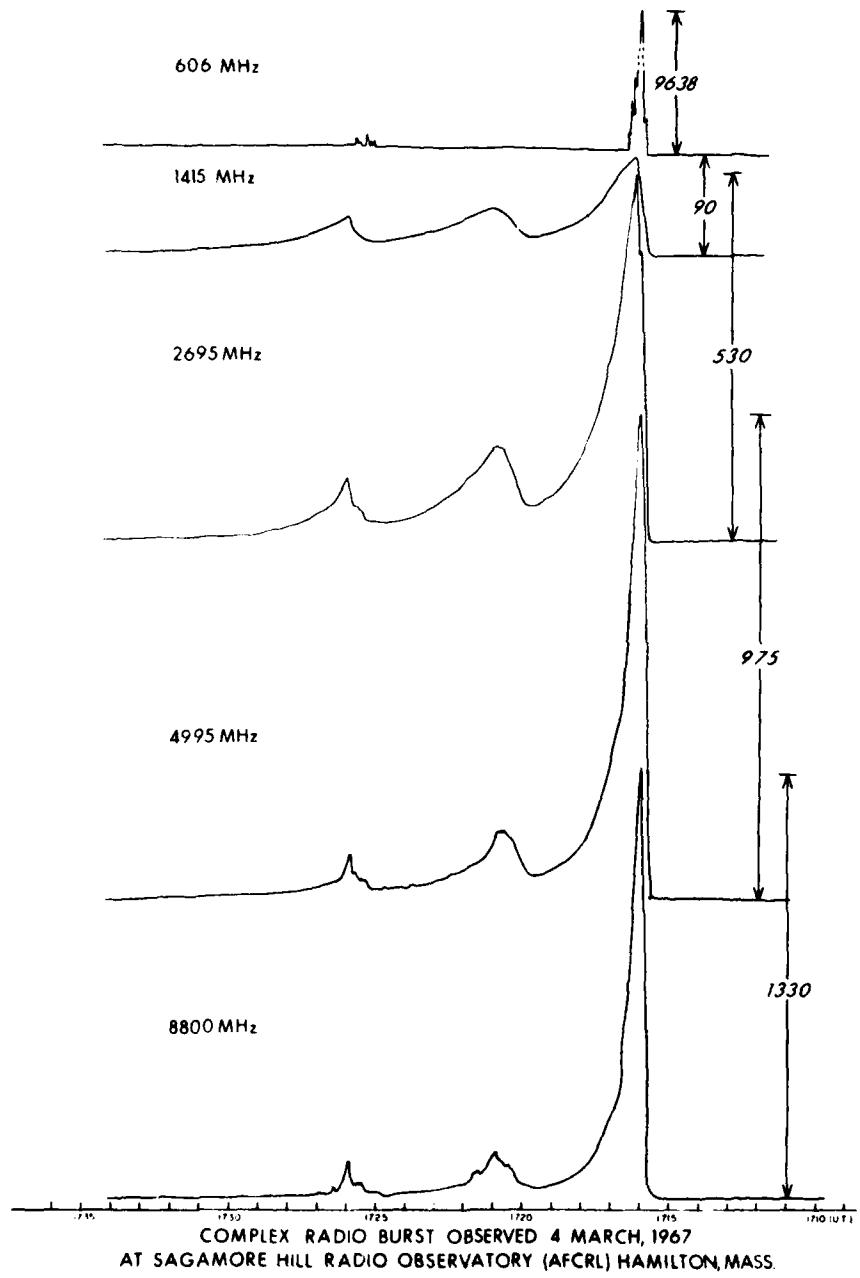


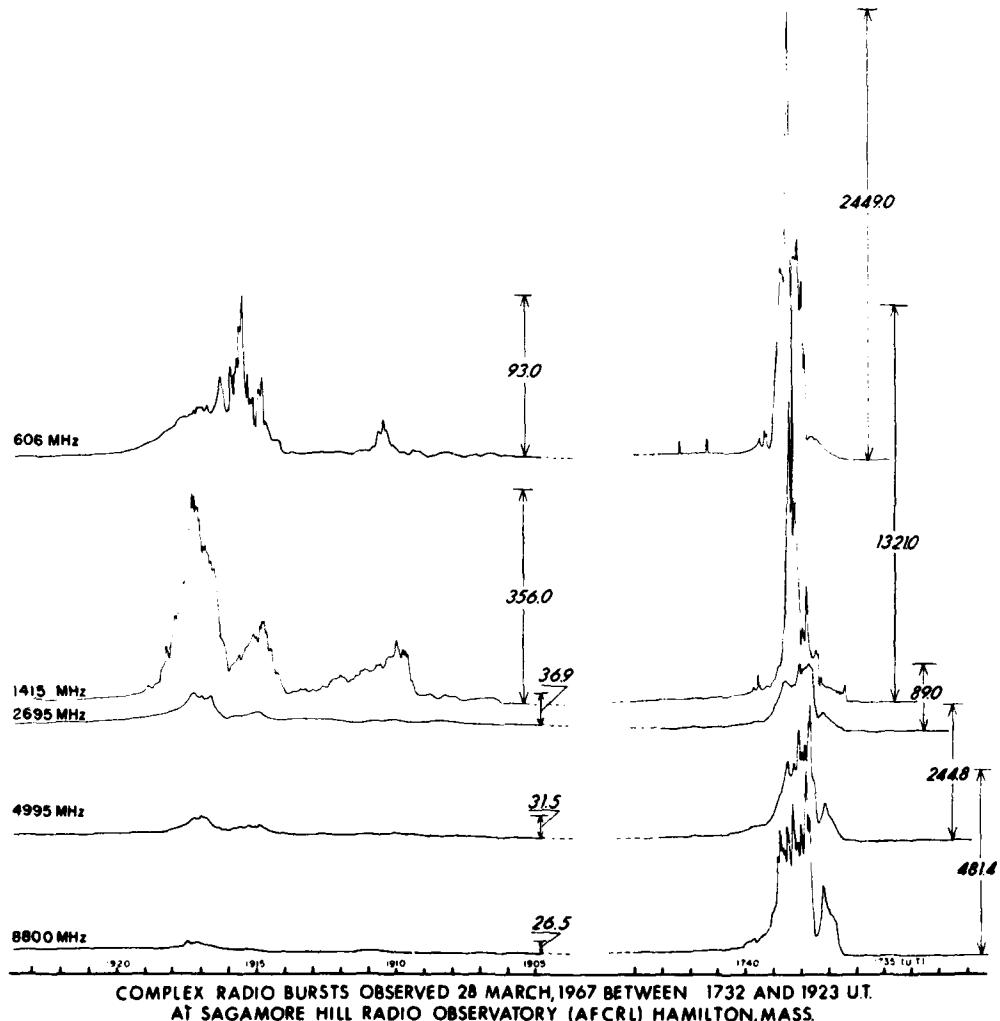
RADIO BURST OBSERVED 13 FEBRUARY 1967 SAGAMORE HILL RADIO OBSERVATORY (AFCR)
 HAMILTON, MASS - LONG POST BURST INCREASE FOLLOWED, ENDING AT 2017 U.T.
 (Inc. SACRAMENTO PEAK OBSERVATION) A 43 CRITICAL FLARE, MAX 1815 (UT)

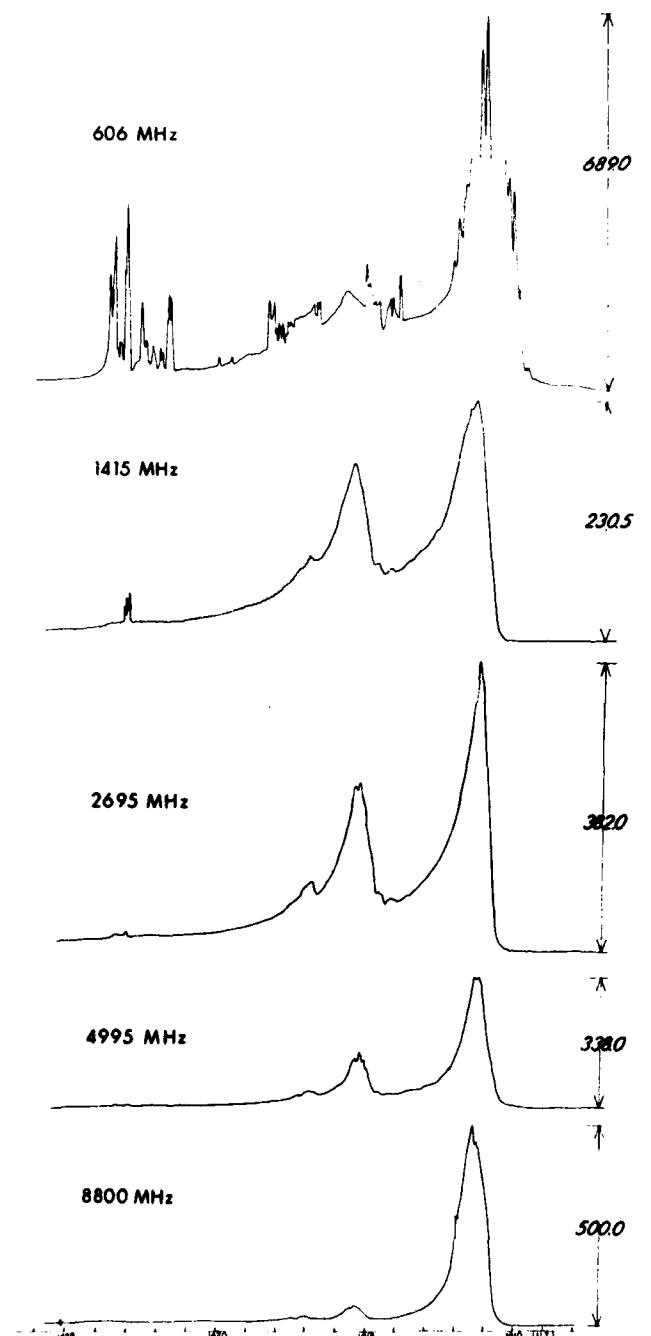




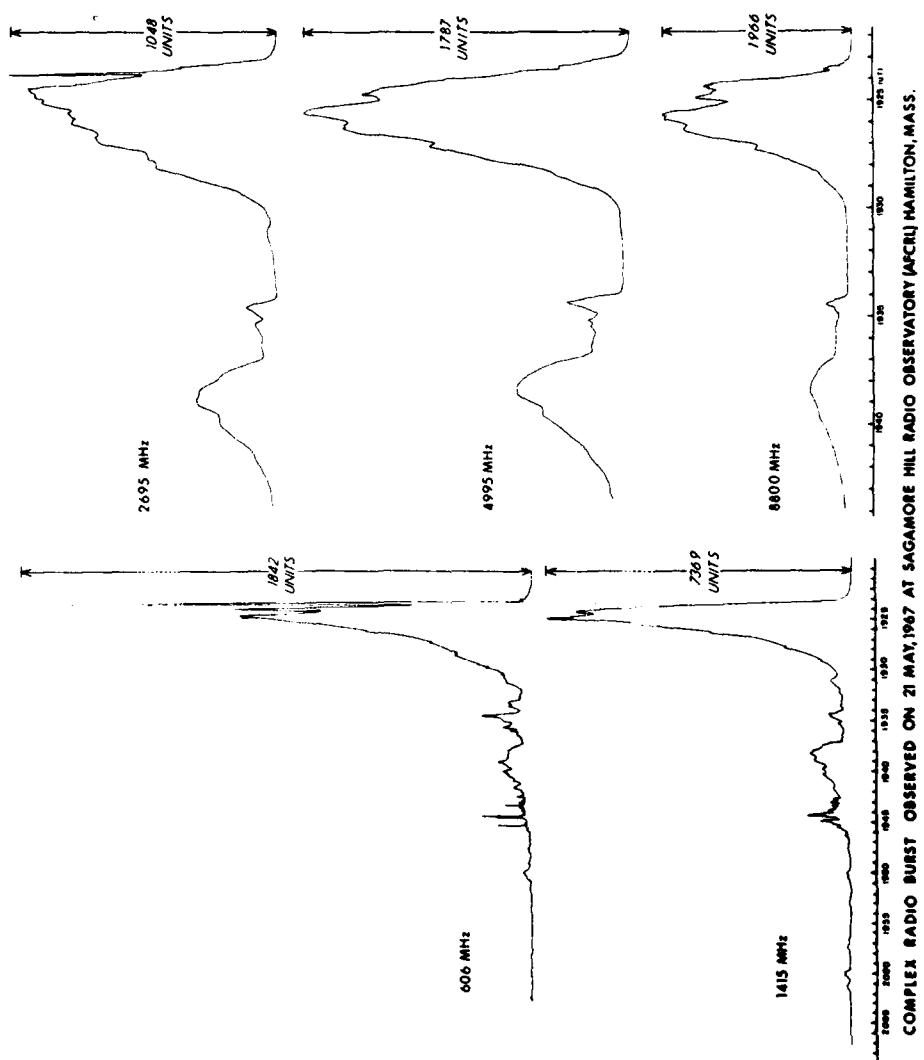
COMPLEX RADIO BURST OBSERVED 27 FEBRUARY, 1967
AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL) HAMILTON, MASS.



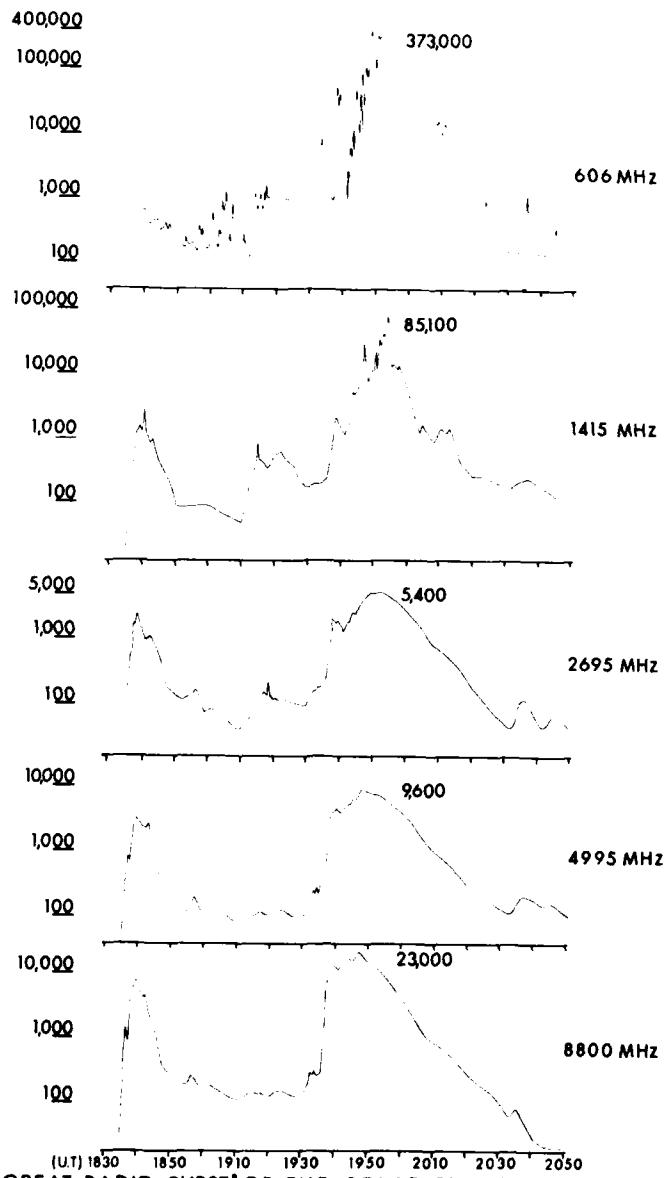




COMPLEX RADIO BURST OBSERVED ON 1 APRIL, 1967
AT SAGAMORE HILL RADIO OBSERVATORY-HAMILTON, MASS.



COMPLEX RADIO BURST OBSERVED ON 21 MAY, 1967 AT SAGAMORE HILL RADIO OBSERVATORY (ACR) HAMILTON, MASS.



GREAT RADIO BURST* OF THE SOLAR PROTON FLARE
23 MAY, 1967 SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.
(*CHART RECONSTRUCTED-FRUX VALUES PLOTTED AT INTERVALS OF ONE MINUTE OR LESS)
(FLUX DENSITY IN UNITS OF $10^{-20} \text{ Wm}^{-2} \text{ Hz}^{-1}$)

(FLUX DENSITY IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$)

606 MHz

$T=8.8$

1415 MHz

9.3

4995 MHz

700

2695 MHz

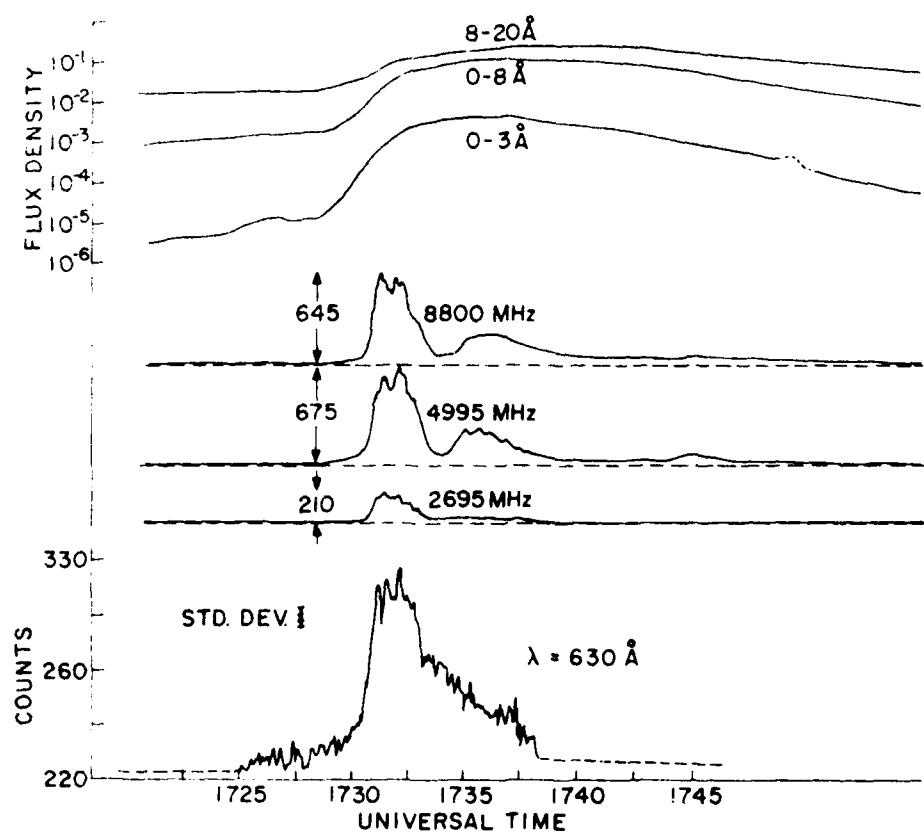
22.5

8800 MHz

1170

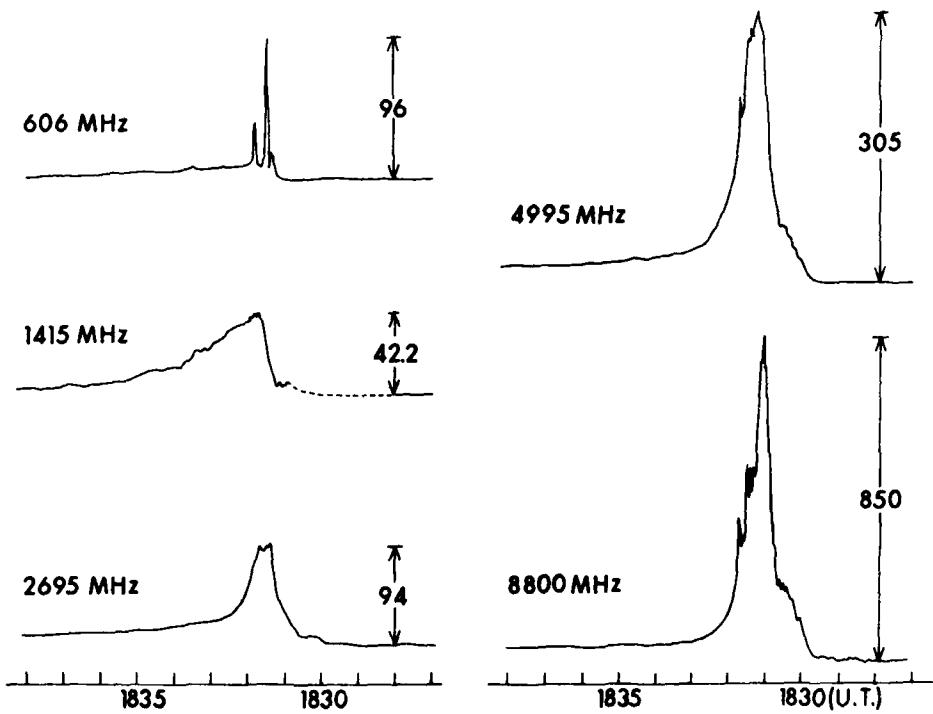
1435 1430 1425 1435 1430 1425 (U.T.)

COMPLEX RADIO BURST OBSERVED ON 25 JULY, 1967
AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL)
HAMMOND, MASS.

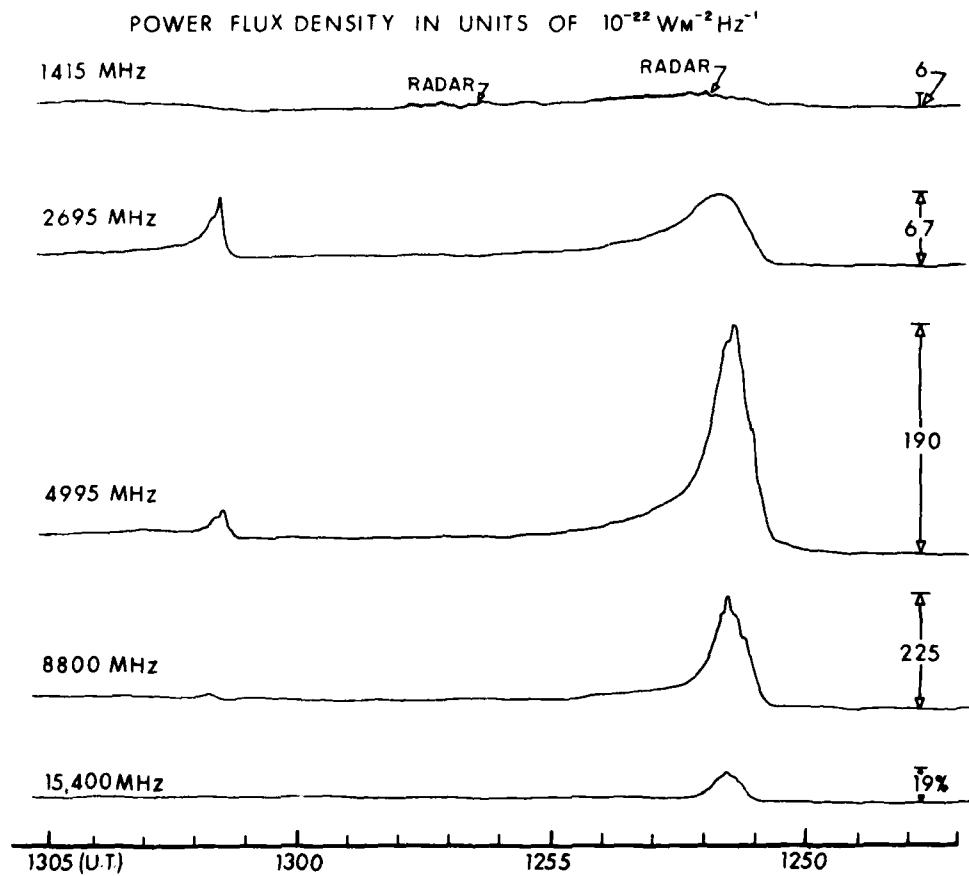


CM. RADIO, SOFT X-RAY AND ULTRA VIOLET BURSTS ASSOCIATED
WITH 2B FLARE ON 1 AUGUST 1967. A SUDDEN FREQUENCY DEVIATION
EVENT (SFD) WITH MAX. WAS OBSERVED AT 1731 U.T.

POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$

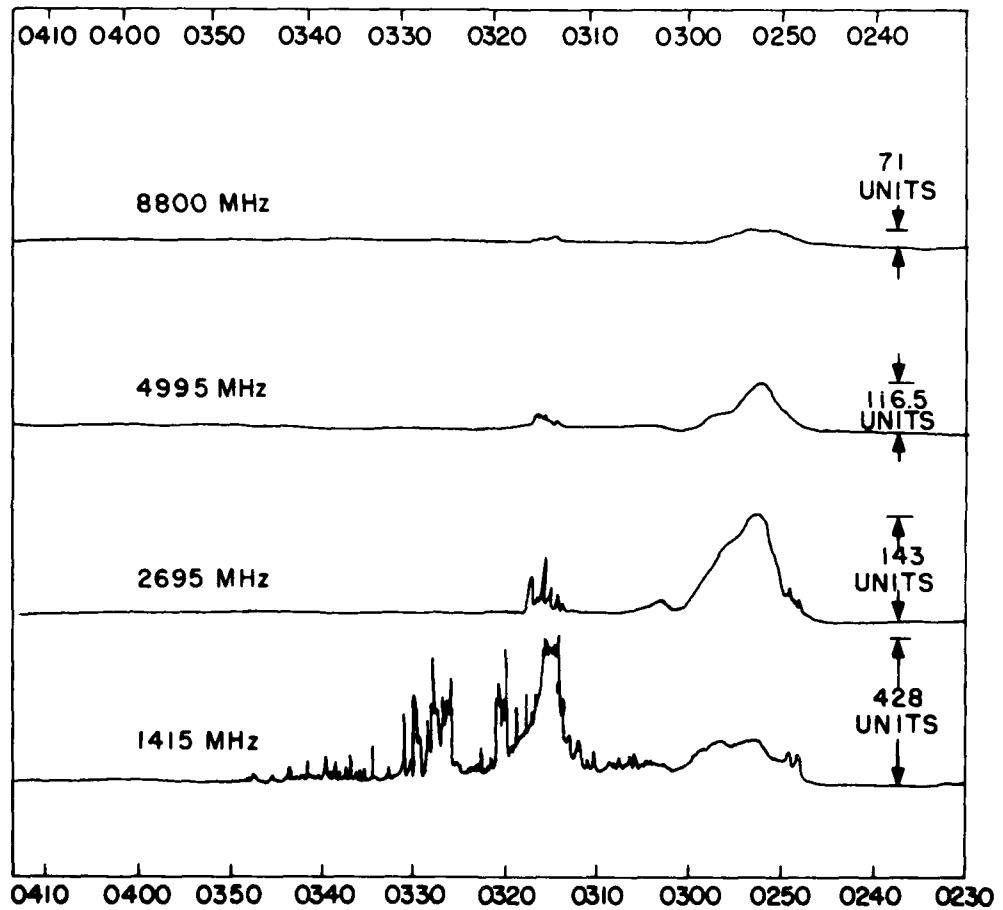


SIMPLE 2/COMPLEX RADIO BURST OBSERVED 29 AUGUST, 1967
AT SAGAMORE HILL RADIO OBSERVATORY (AFCRL)
HAMILTON, MASS.



SIMPLE 2* RADIO BURST OBSERVED ON 1 DECEMBER, 1967
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

*SIMPLE 3 ON 1415 MHz



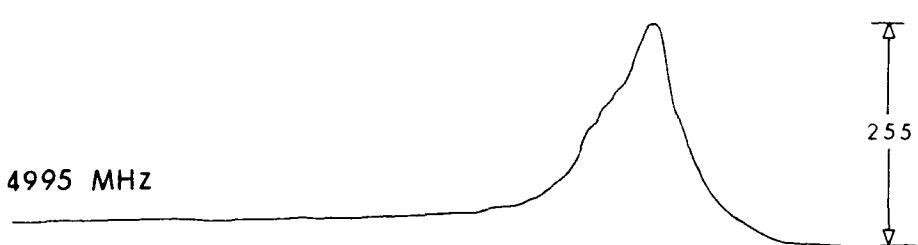
COMPLEX BURST OBSERVED AT MANILA OBSERVATORY
ON DECEMBER 16, 1967 STARTING AT 0248 U.T.
BURST INTENSITY IN UNITS OF $10^{-22} \text{wm}^{-2} \text{ Hz}^{-1}$.

POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$

2695 MHz



4995 MHz



8800 MHz



1420 (U.T.)

1415

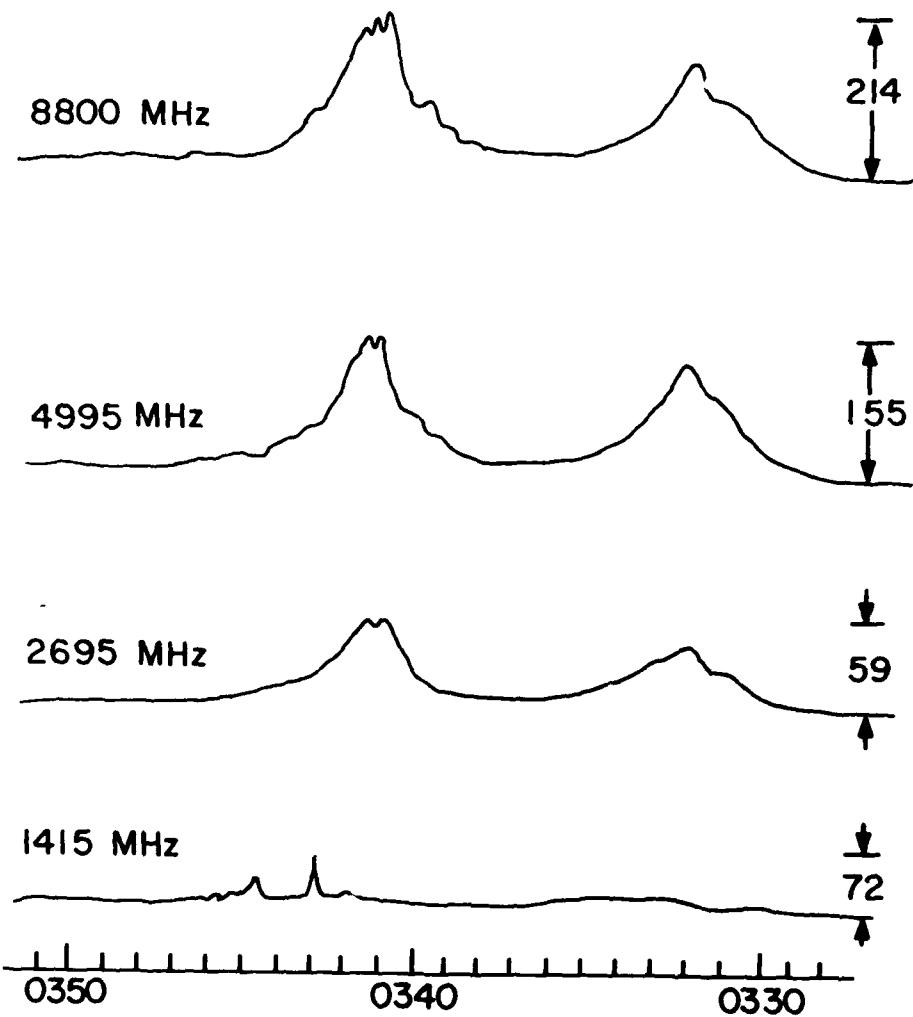
1410

1405

SIMPLE 2 RADIO BURST OBSERVED ON 27 DEC, 1967
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

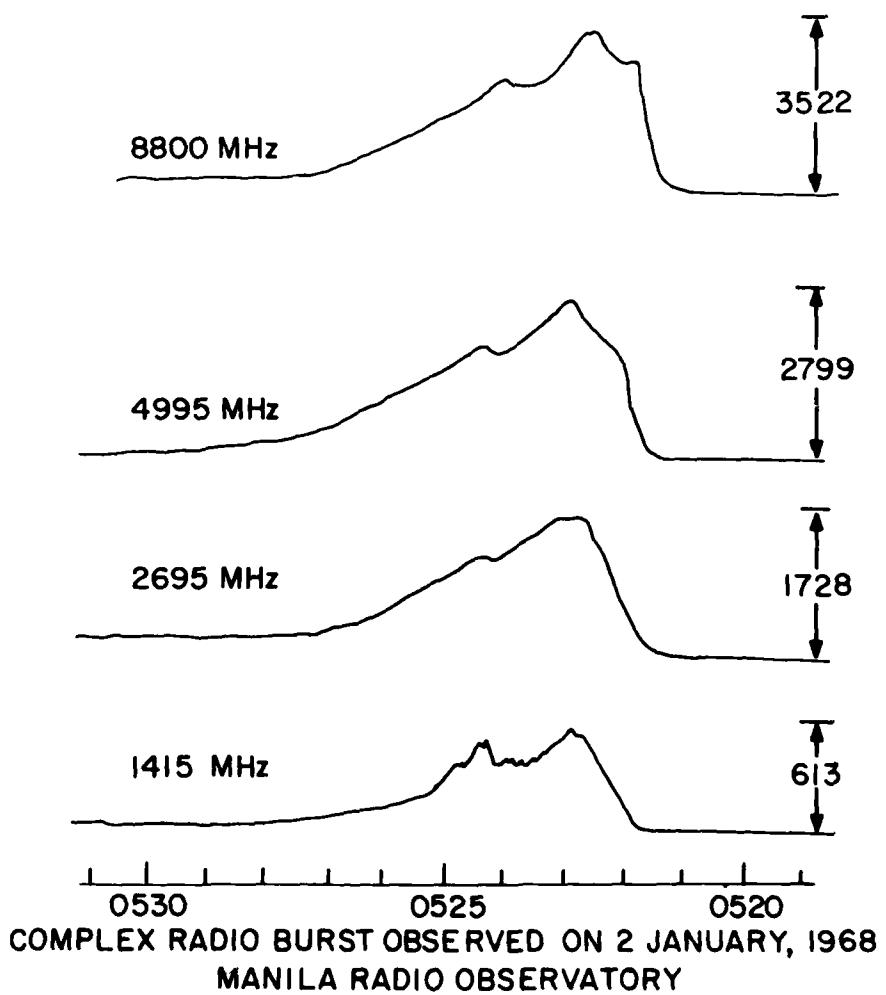
**Solar Radio Bursts
1968**

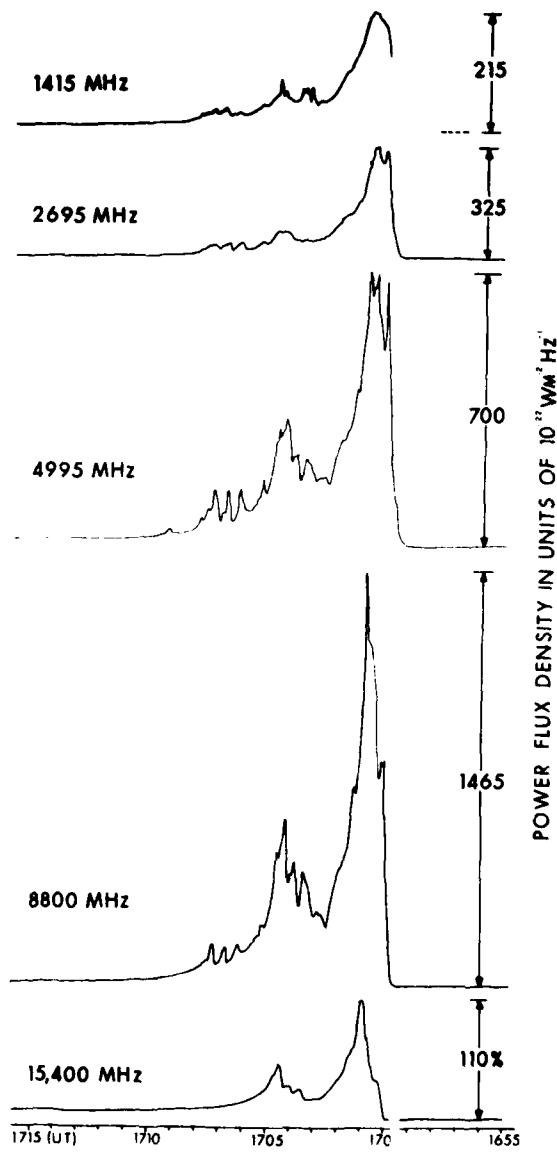
POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ w m}^{-2} \text{ Hz}^{-1}$



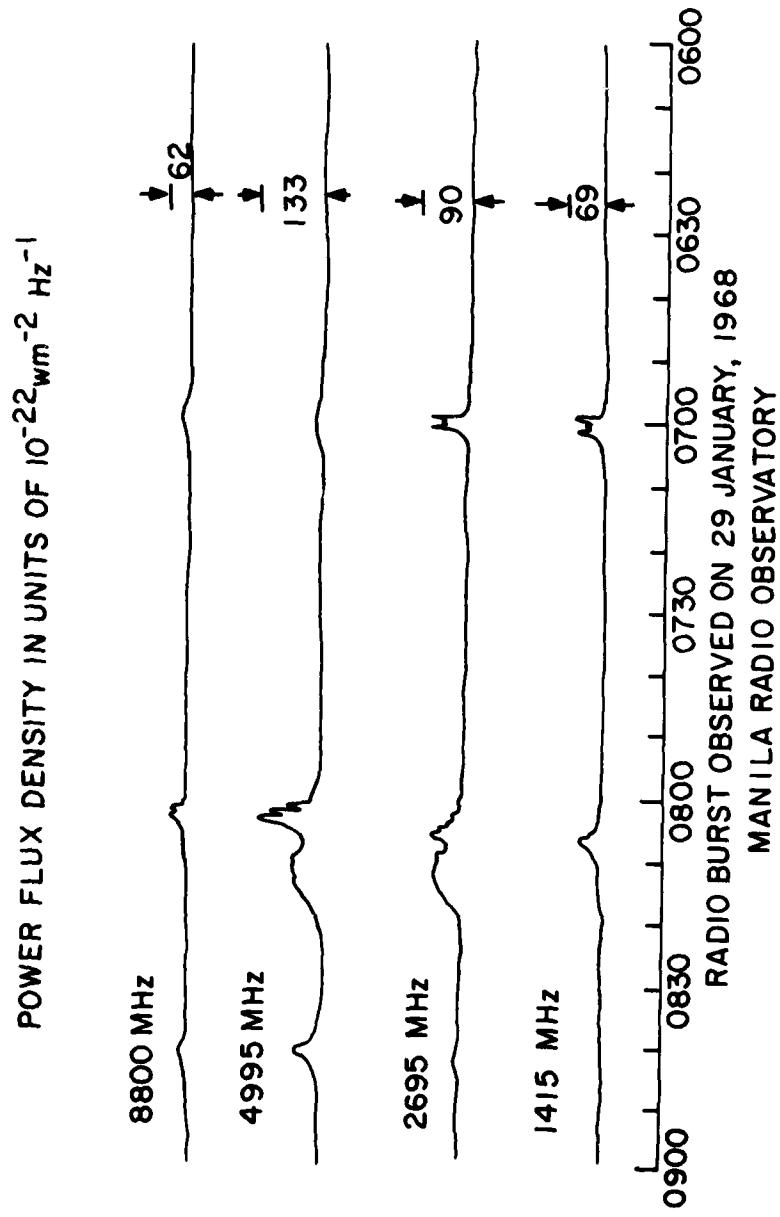
RADIO BURST OBSERVED ON 1 JANUARY, 1968
MANILA RADIO OBSERVATORY

POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$

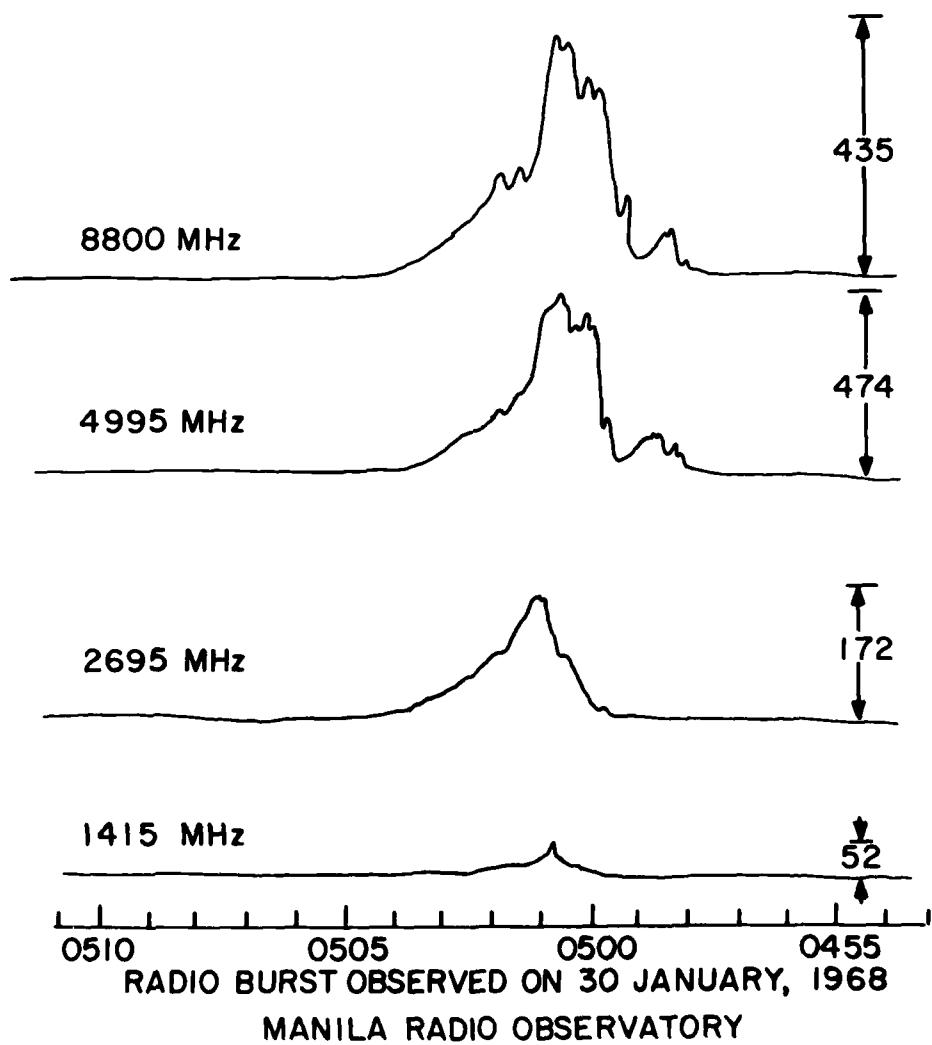


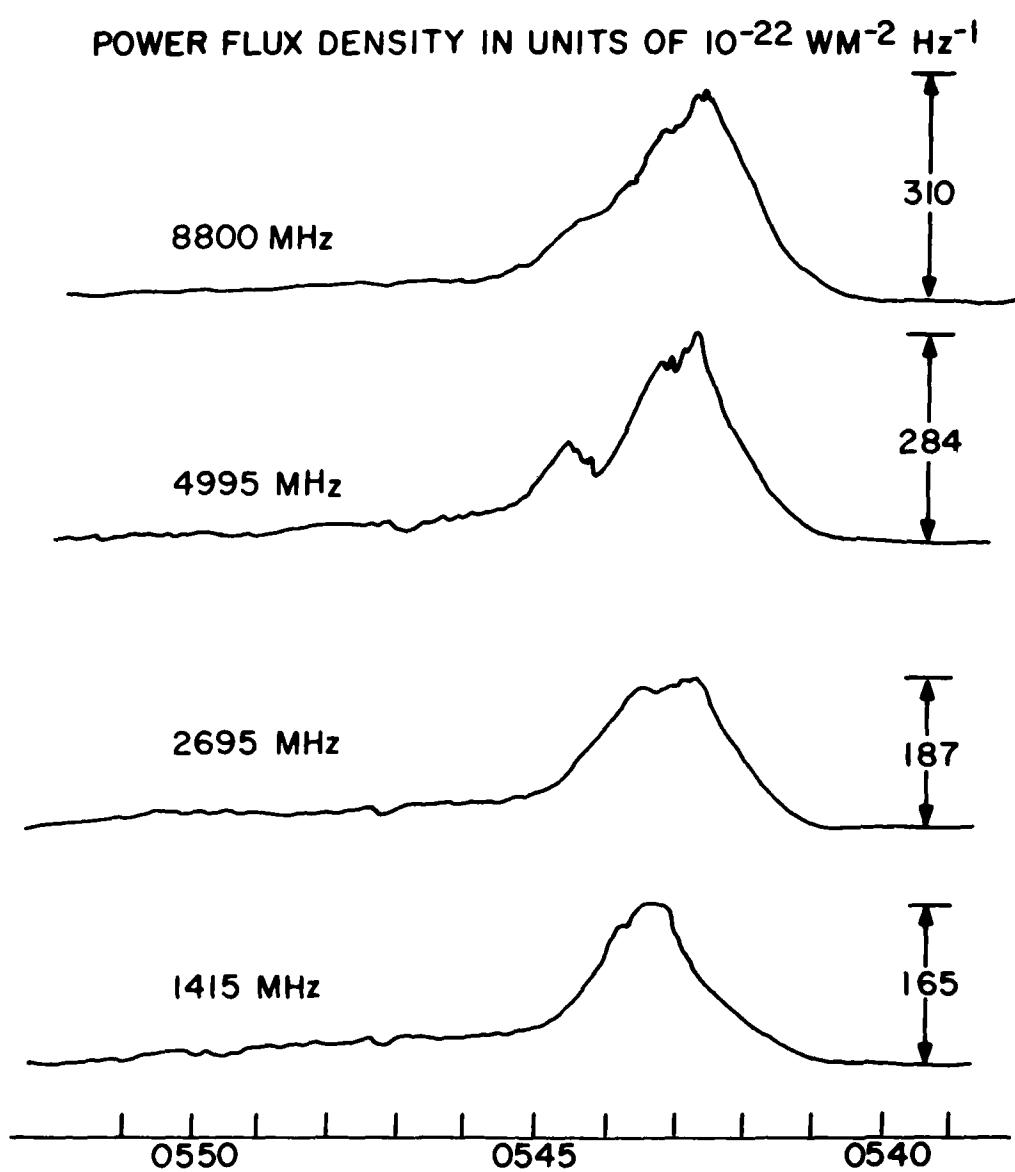


COMPLEX RADIO BURST OBSERVED 11 JANUARY, 1968
AT SAGAMORE HILL RADIO OBSERVATORY
HAMMOND, MASS.



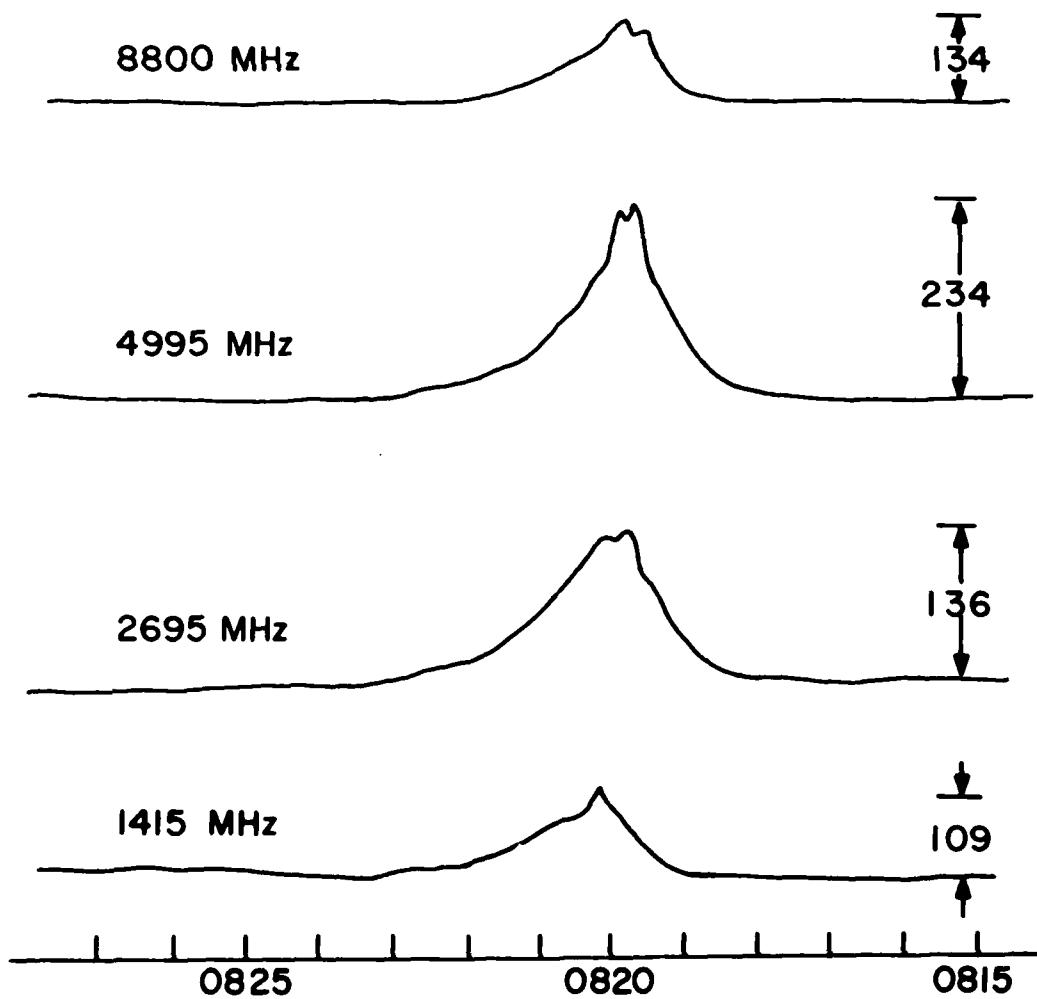
POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$



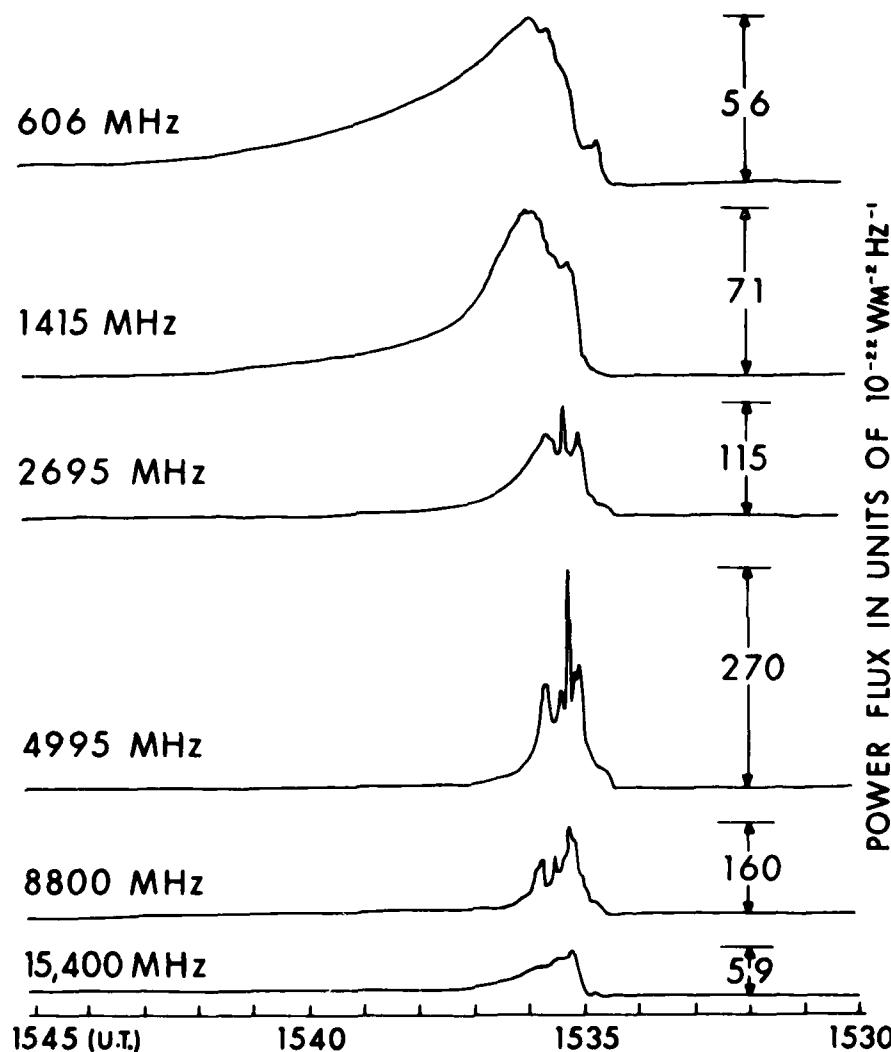


RADIO BURST OBSERVED ON 2 FEBRUARY, 1968
MANILA RADIO OBSERVATORY

POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ WM}^{-2} \text{ Hz}^{-1}$

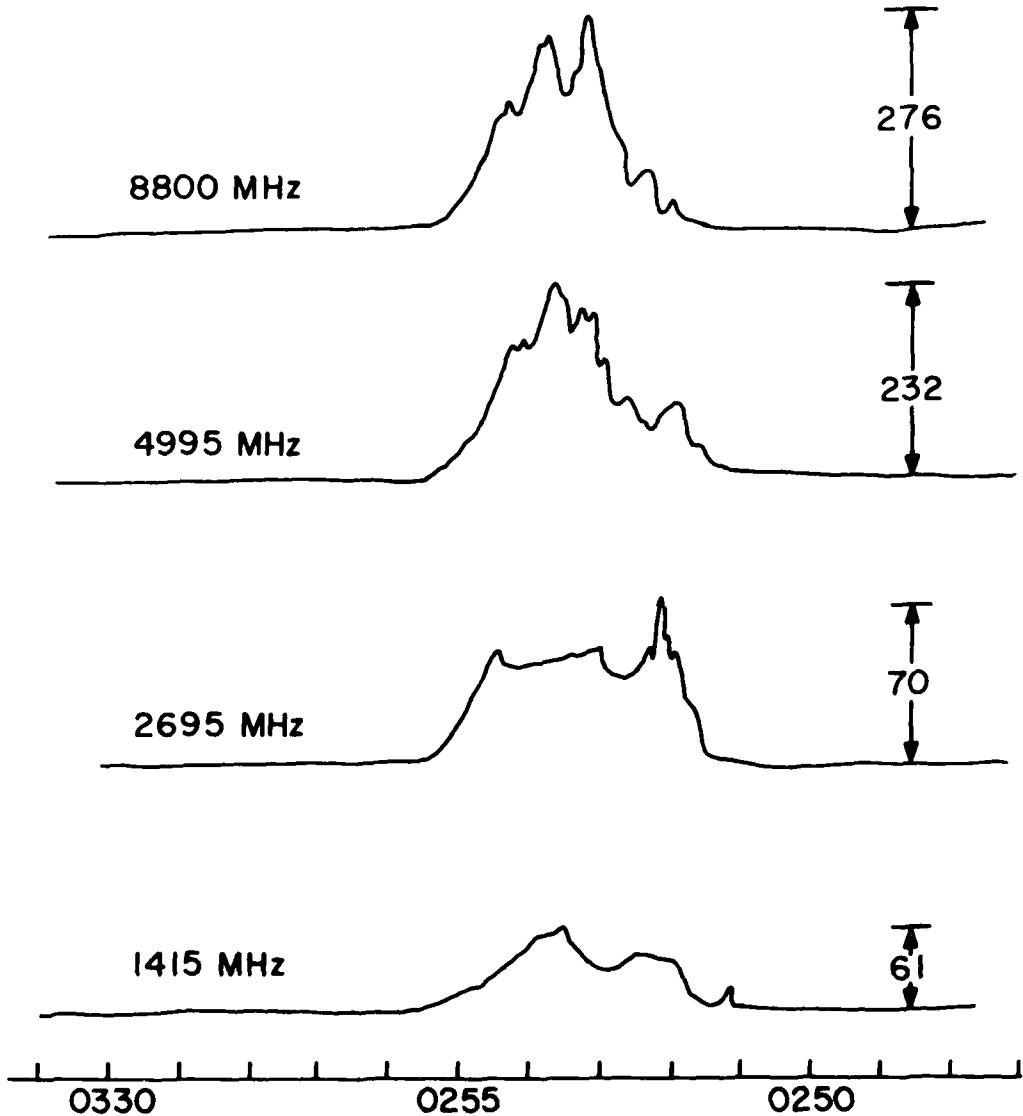


RADIO BURST OBSERVED ON 5 FEBRUARY, 1968
MANILA RADIO OBSERVATORY



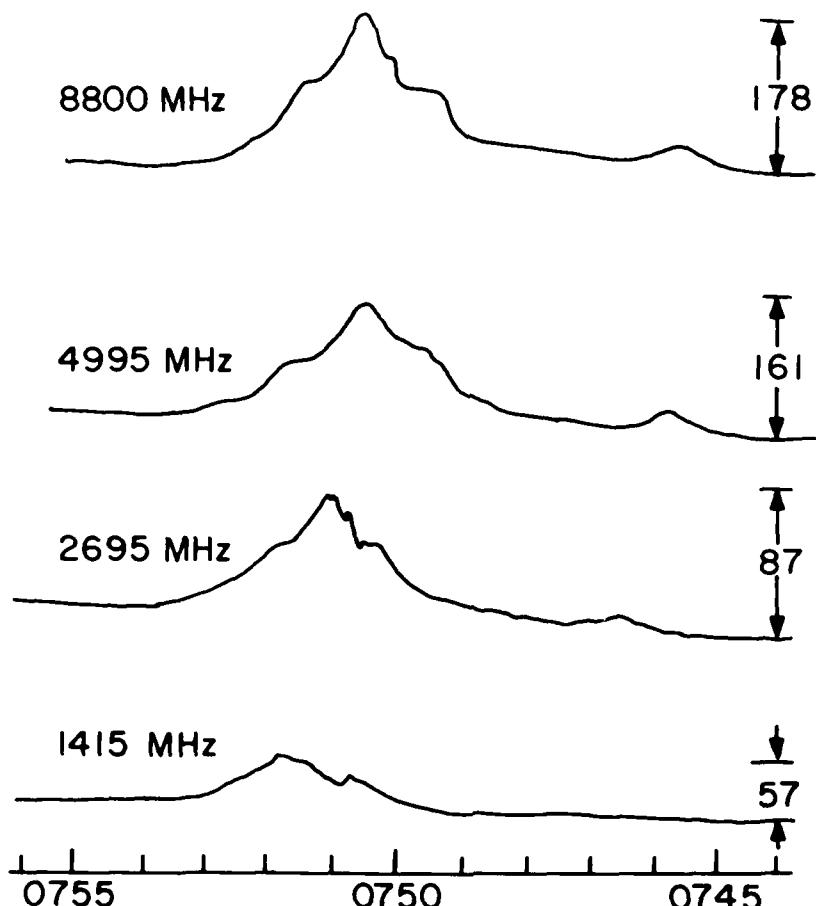
SIMPLE 2 & COMPLEX RADIO BURST OBSERVED ON
14 FEBRUARY, 1968 AT SAGAMORE HILL RADIO
OBSERVATORY (AFCRL) HAMILTON, MASS.

POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ WM}^{-2} \text{ Hz}^{-1}$



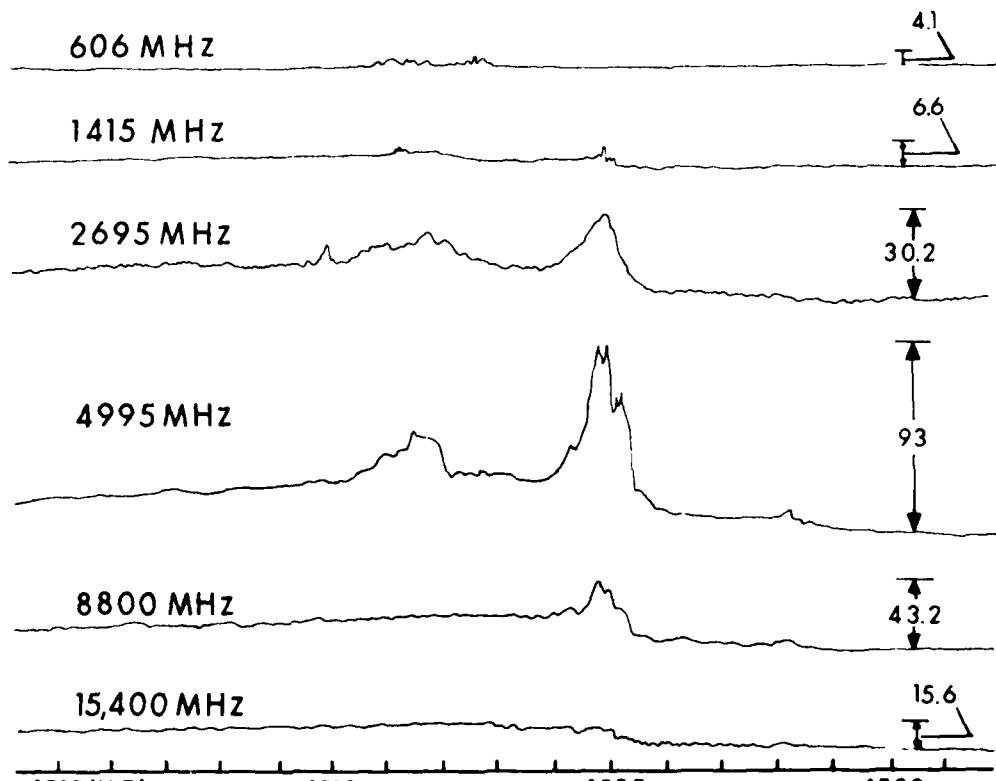
RADIO BURST OBSERVED ON 17 FEBRUARY, 1968
MANILA RADIO OBSERVATORY

POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ WM}^{-2} \text{ Hz}^{-1}$

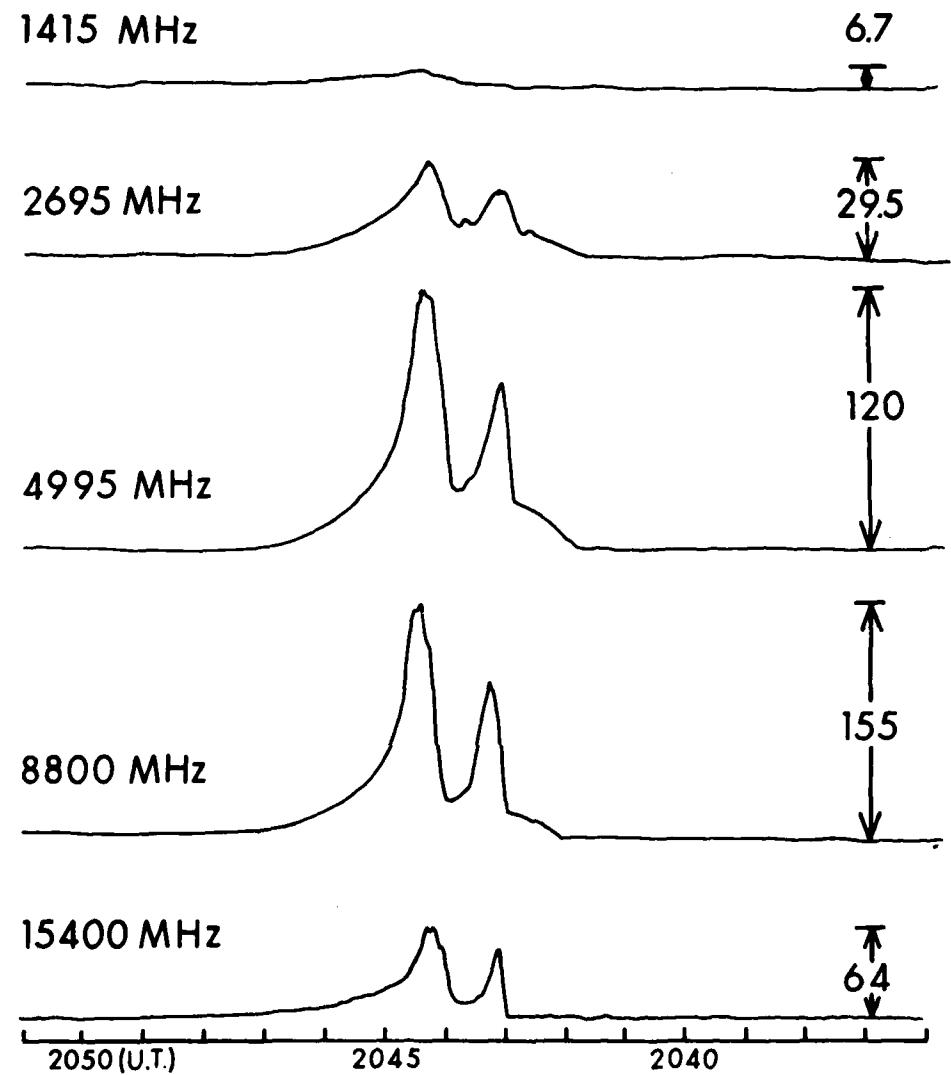


RADIO BURST OBSERVED ON 24 MARCH, 1968
MANILA RADIO OBSERVATORY

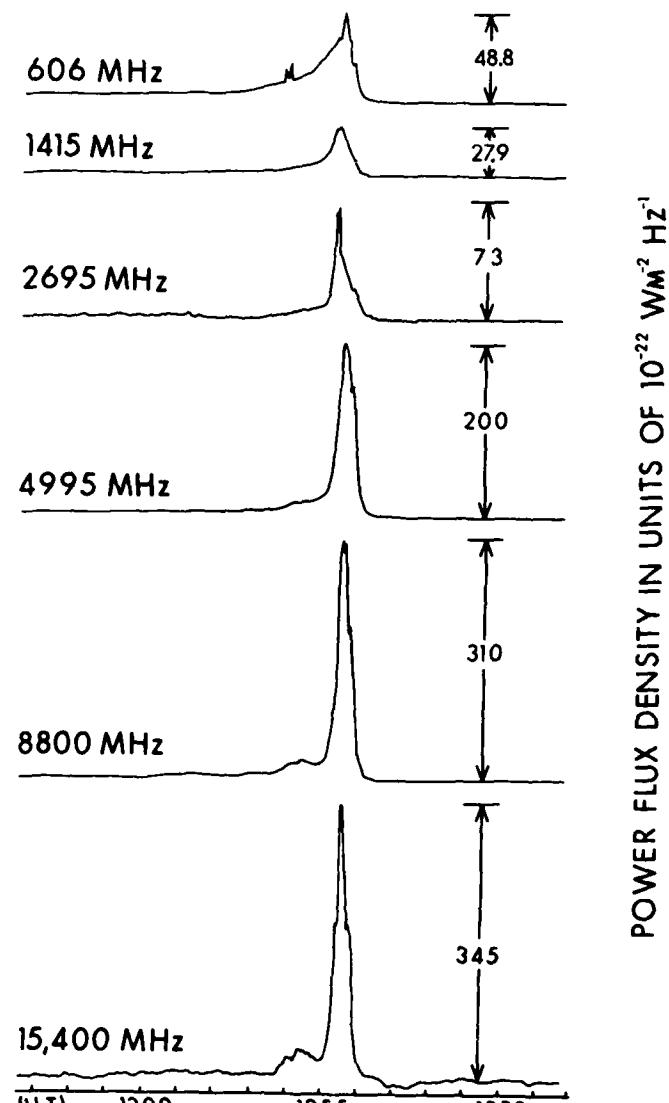
C1026



SIMPLE 3 AND COMPLEX RADIO BURST OBSERVED ON
25 MARCH, 1968 AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

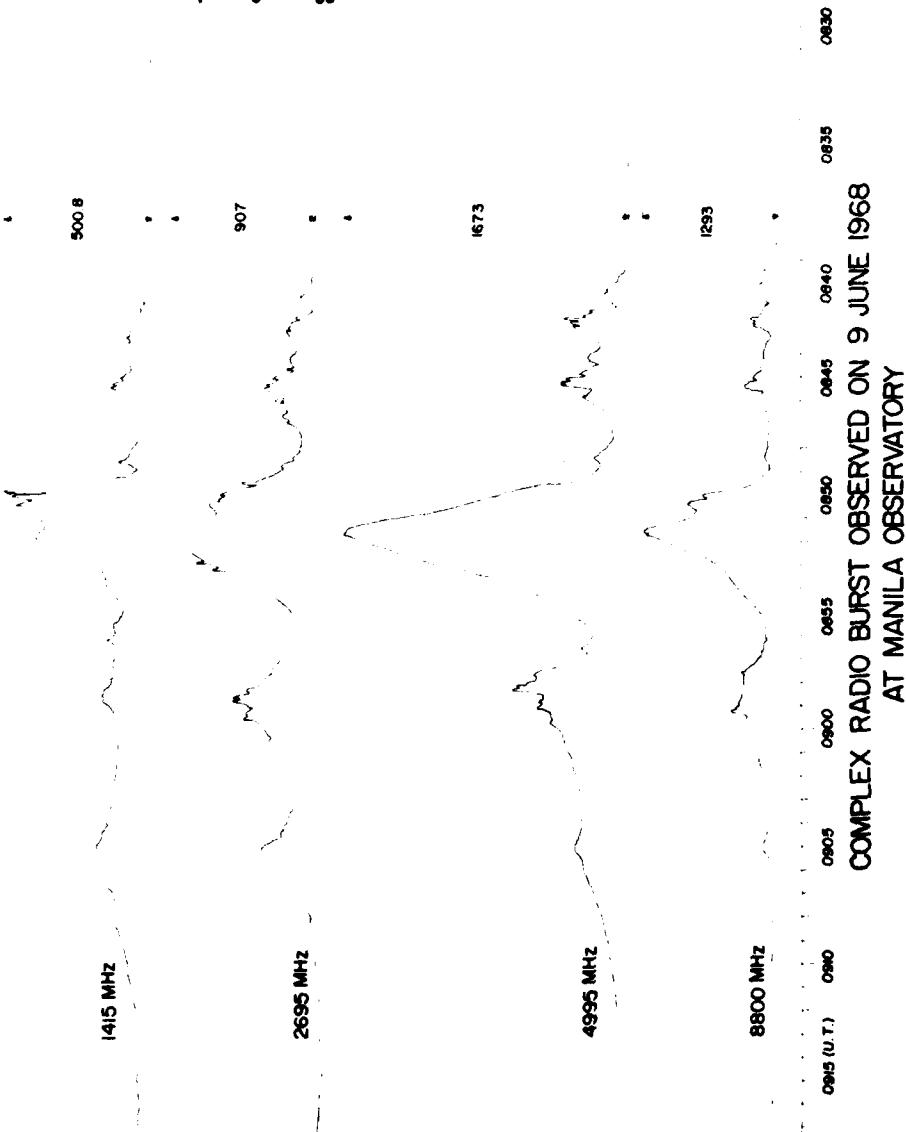


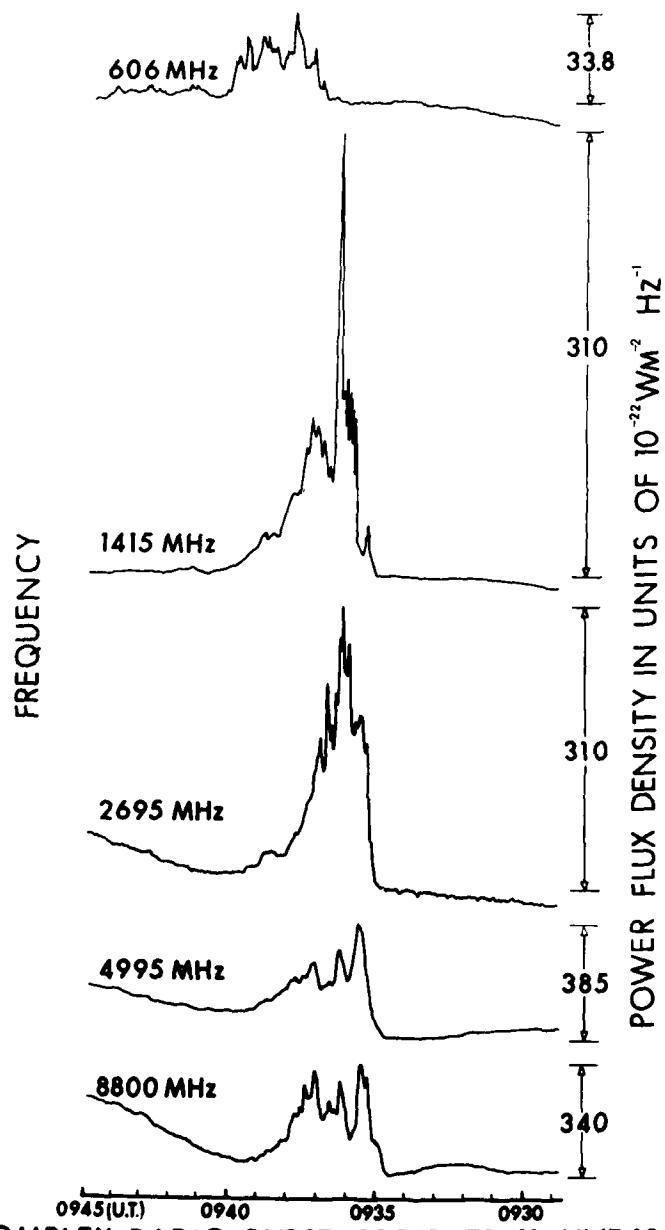
COMPLEX RADIO BURST OBSERVED
3 APRIL, 1968 AT SAGAMORE HILL
RADIO OBSERVATORY, HAMILTON, MASS.



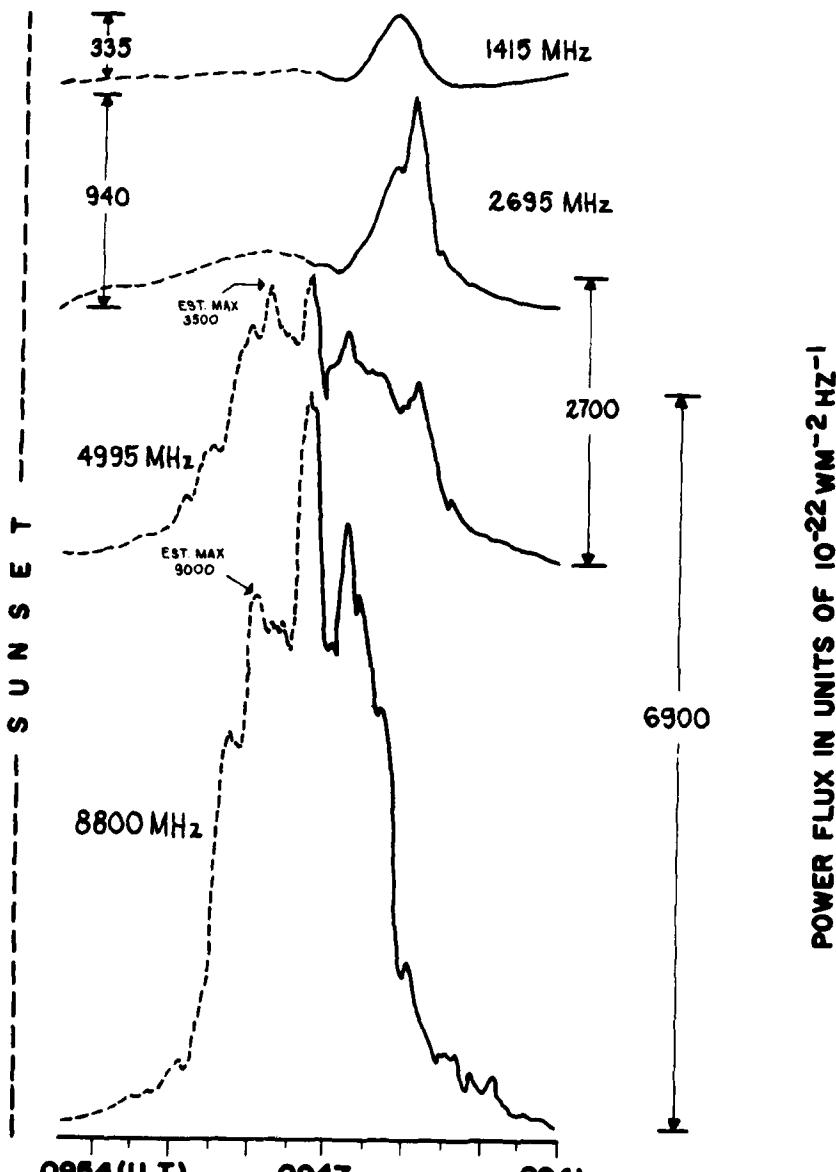
SIMPLE 2 RADIO BURST OBSERVED 24 MAY, 1968
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

POWER FLUX IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$

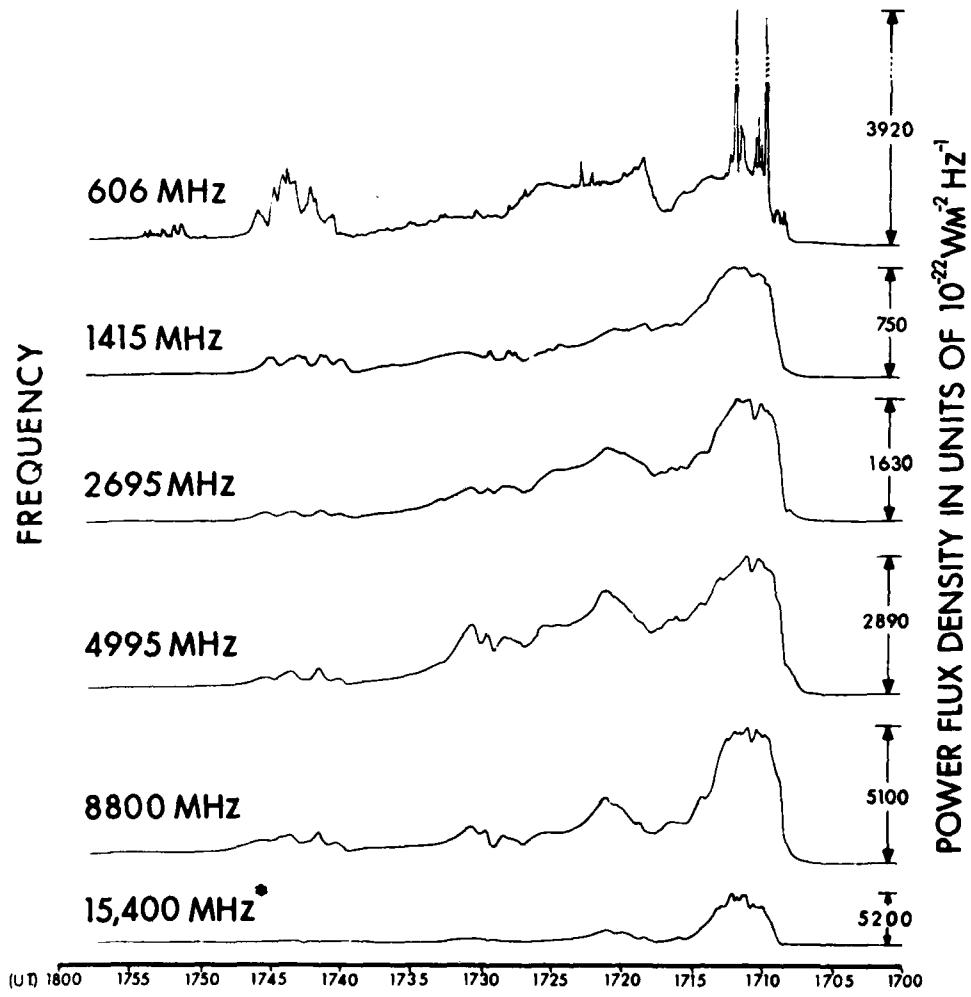




COMPLEX RADIO BURST OBSERVED 11 JUNE, 1968
AT SAGAMORE HILL OBSERVATORY, HAMILTON, MASS.
(BURST OCCURRED AT SUNRISE)

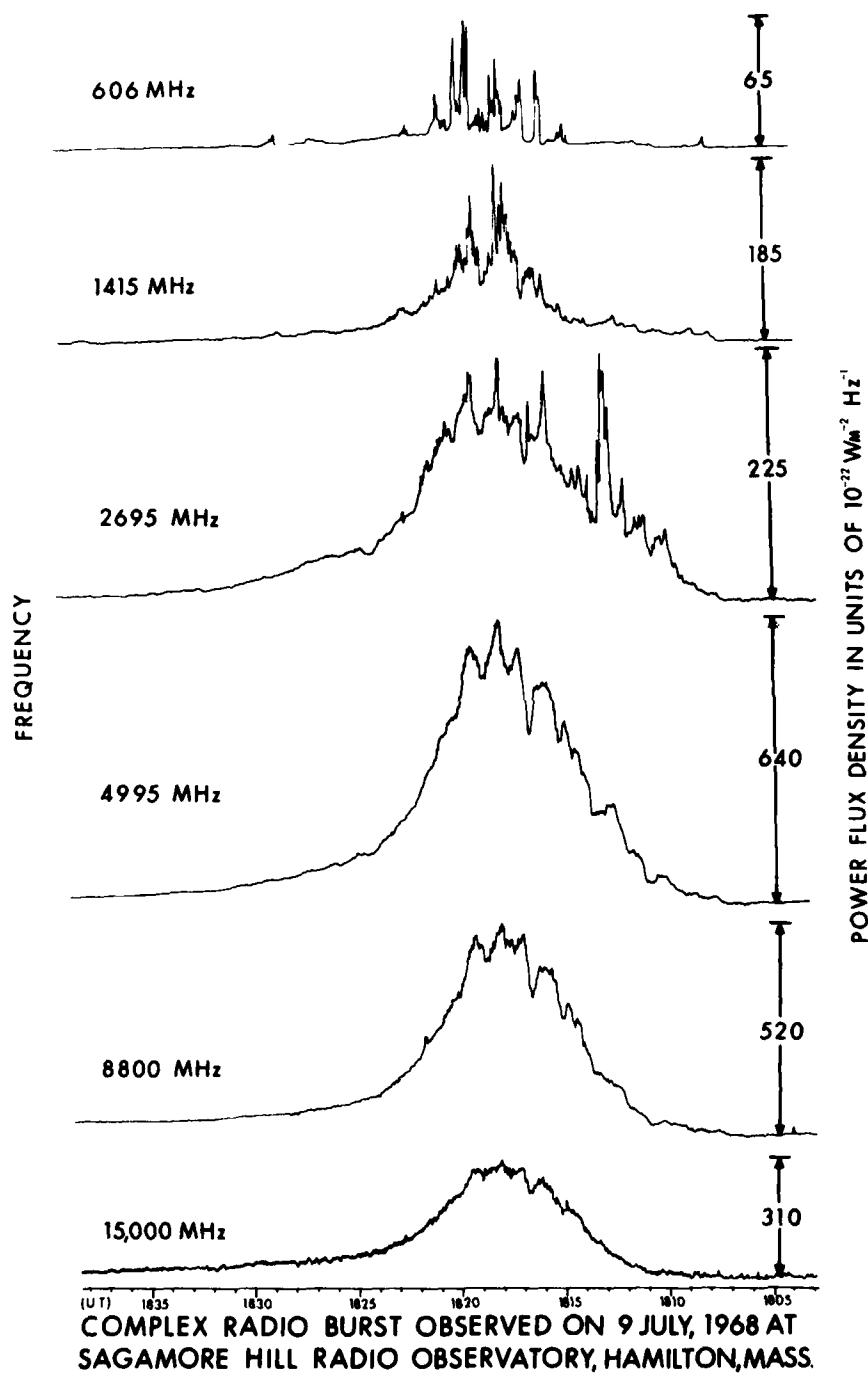


COMPLEX RADIO BURST OBSERVED ON 6 JULY 1968
AT MANILA OBSERVATORY, R.P.

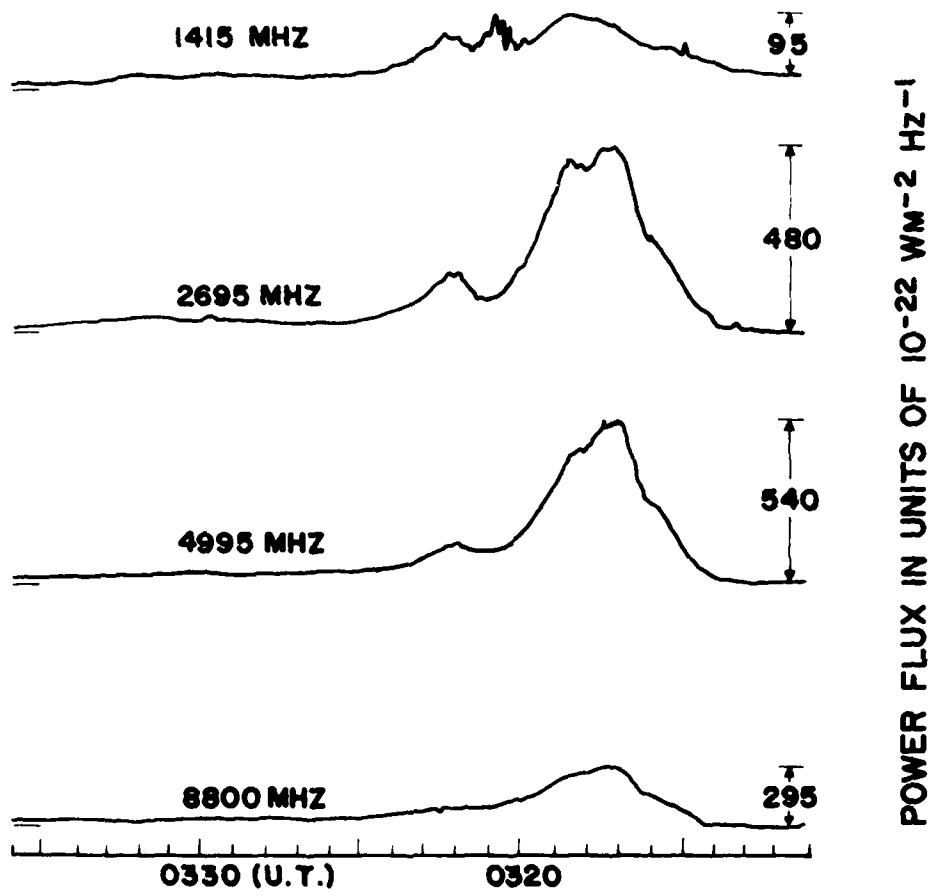


**COMPLEX RADIO BURST OBSERVED 8 JULY, 1968 AT
 SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.**

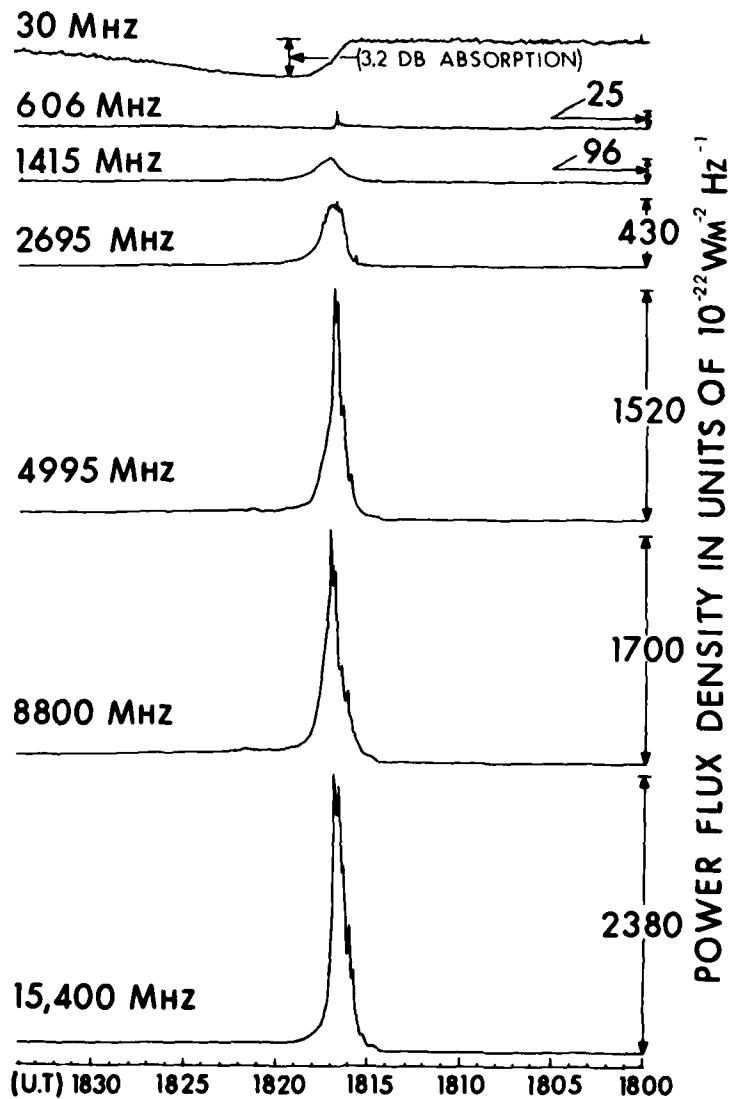
(*15,400 MHz RECORD TAKEN FROM LOW GAIN CHANNEL - ALL OTHER FREQUENCIES FROM MEDIUM GAIN)



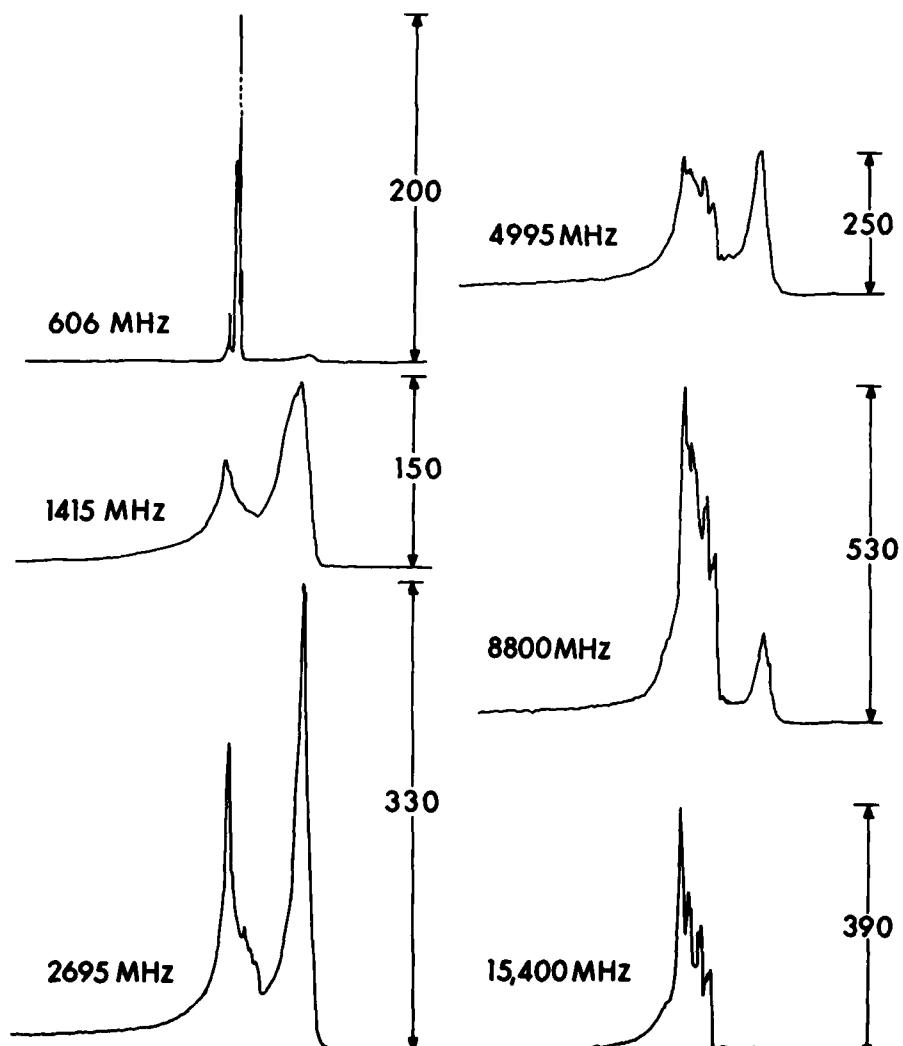
COMPLEX RADIO BURST OBSERVED ON 9 JULY, 1968 AT
 SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.



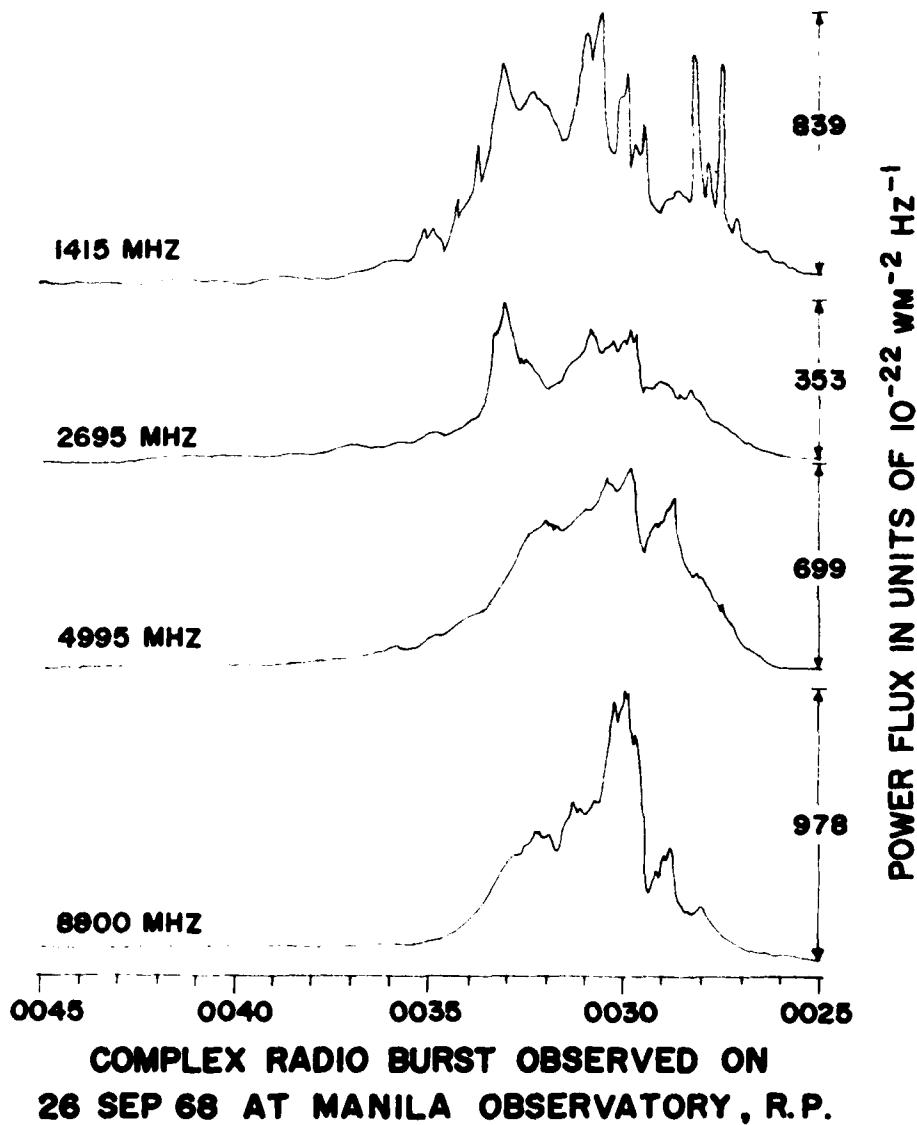
SIMPLE 2 AND COMPLEX RADIO BURST OBSERVED ON
3 AUGUST 1968 AT MANILA OBSERVATORY, R.P.

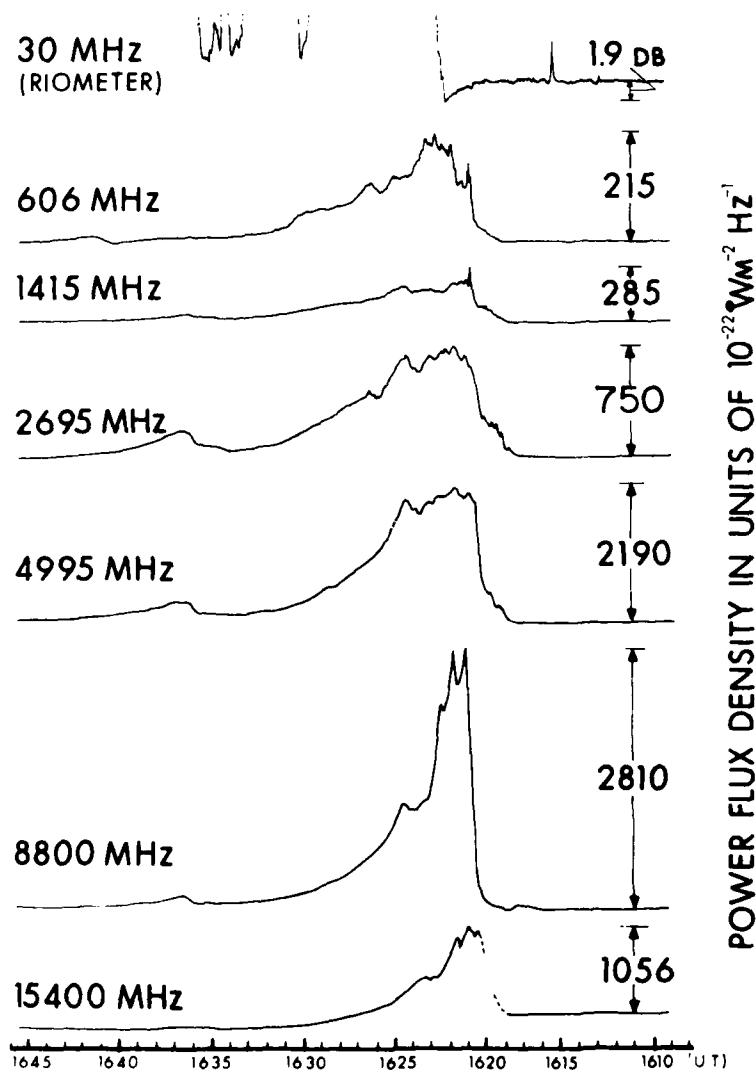


SIMPLE 2 RADIO BURST OBSERVED 8 AUGUST, 1968
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

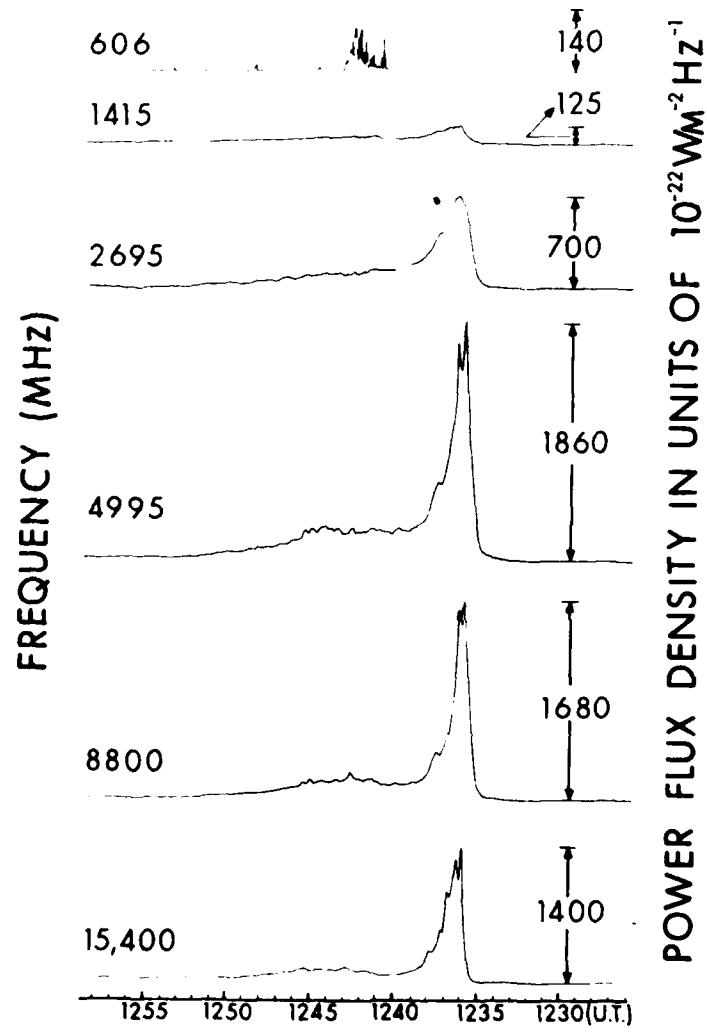


COMPLEX RADIO BURST OBSERVED ON 21 AUGUST, 1968 AT
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

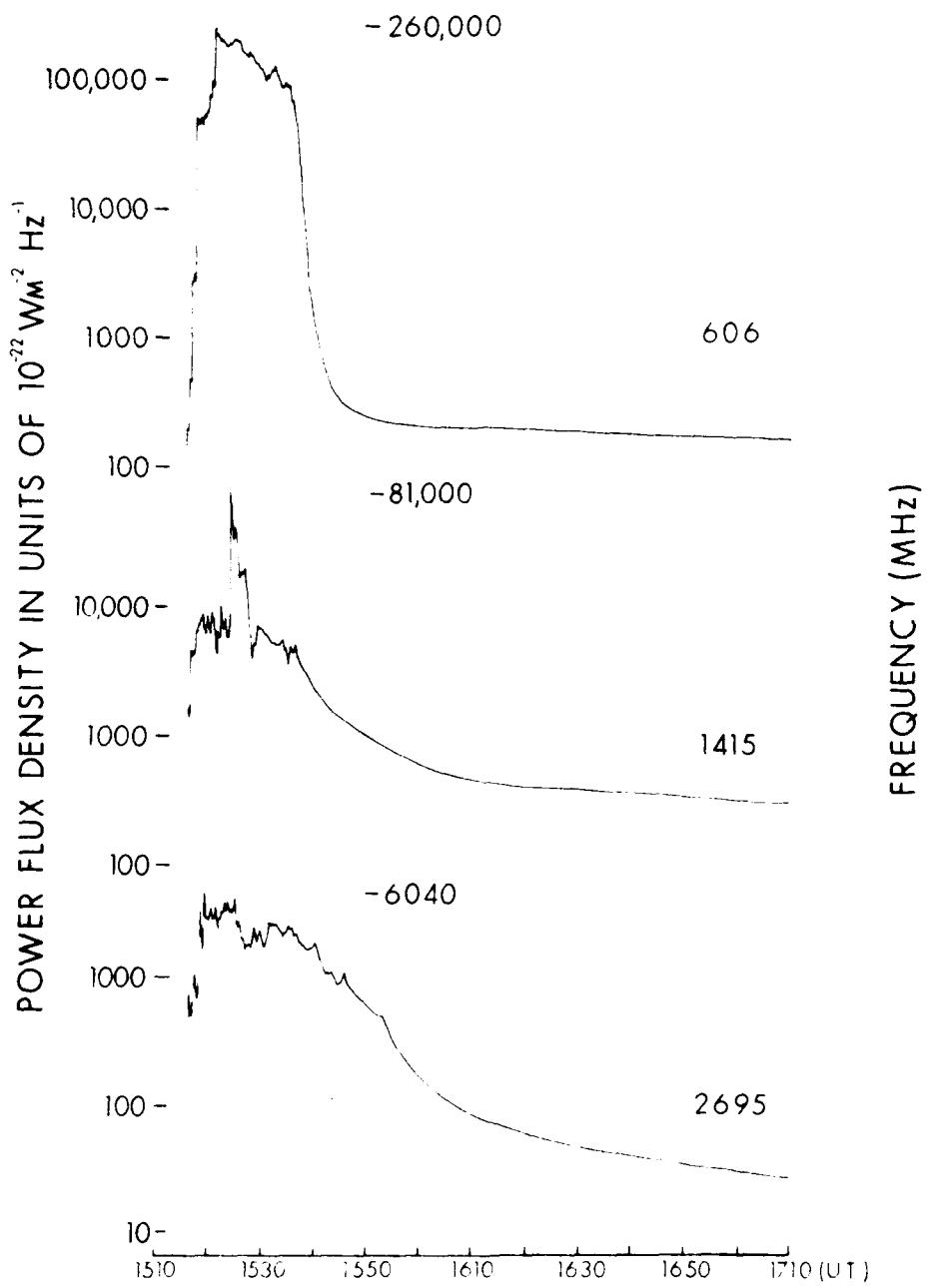




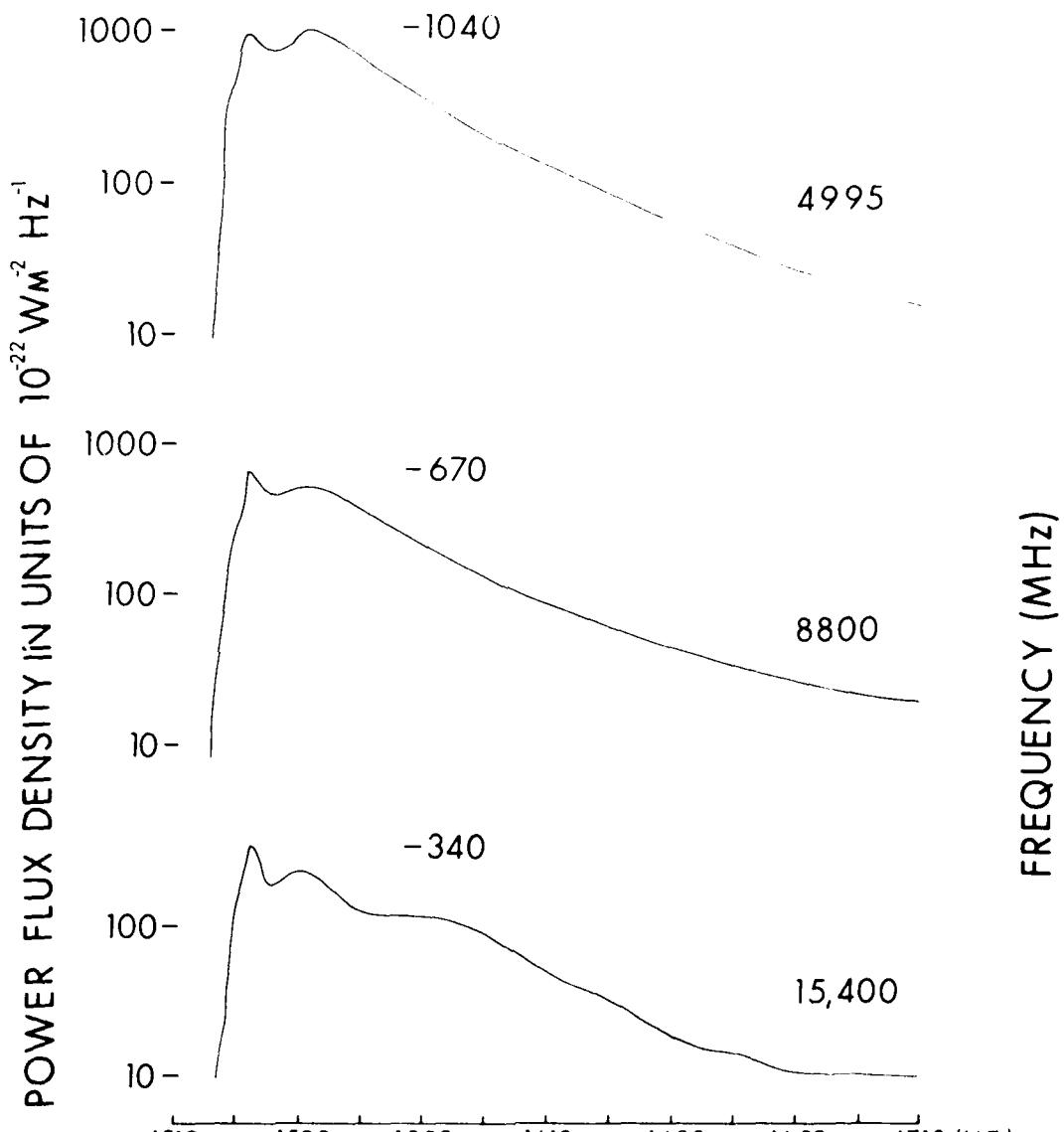
COMPLEX F RADIO BURST - 29 SEPTEMBER, 1968
 AT SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.
 (DEKAMETER TYPE II & IV BURSTS OBSERVED 1617-1644)



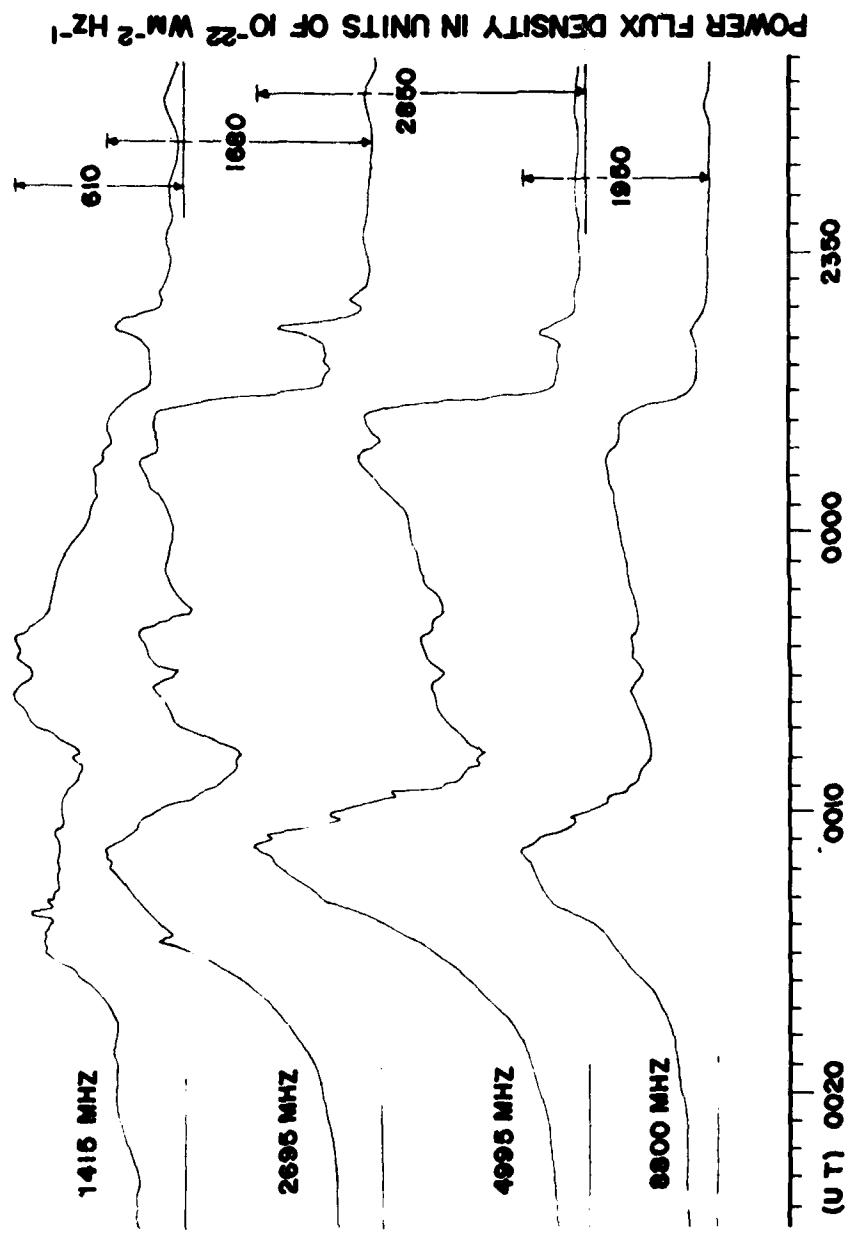
**COMPLEX AND SIMPLE 2 RADIO BURST
OBSERVED ON 27 OCTOBER, 1968
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.**



GREAT BURST OBSERVED ON 29 OCTOBER, 1968
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

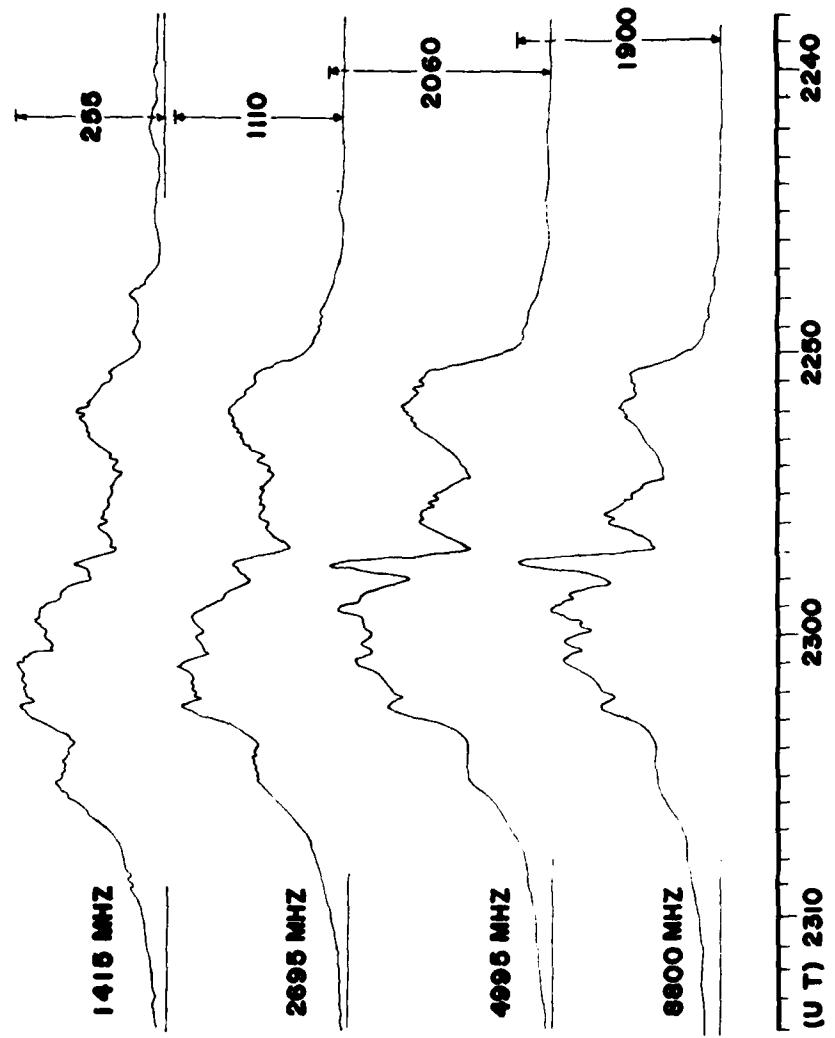


GREAT BURST OBSERVED ON 29 OCTOBER, 1968
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

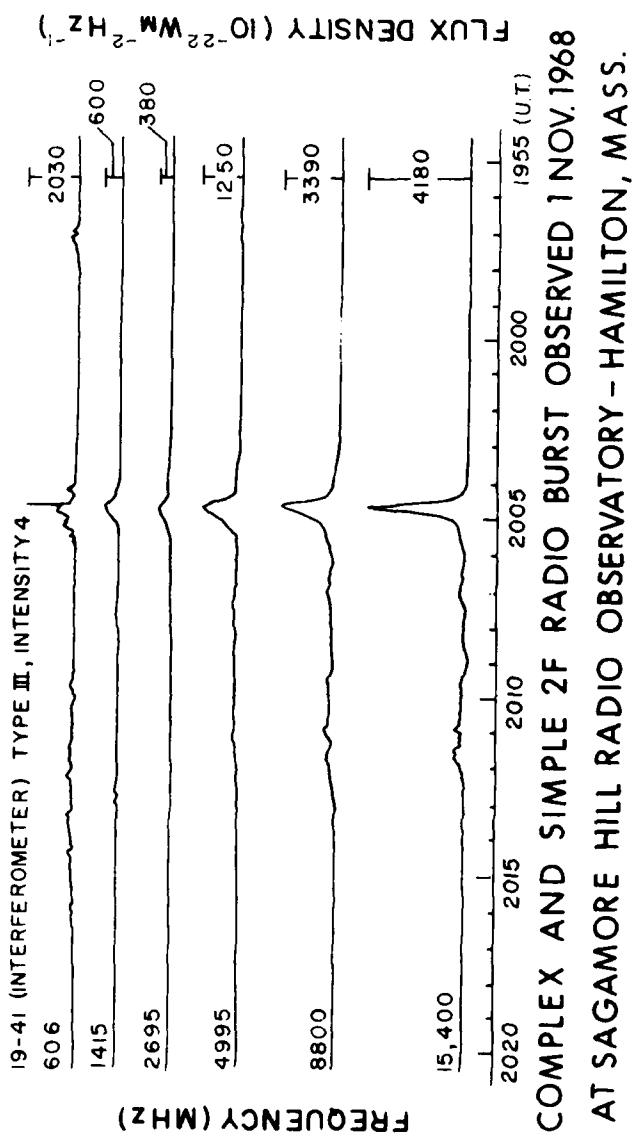


Complex with PBI Radio Burst Observed 30 October 1968 at Manila Radio Observatory

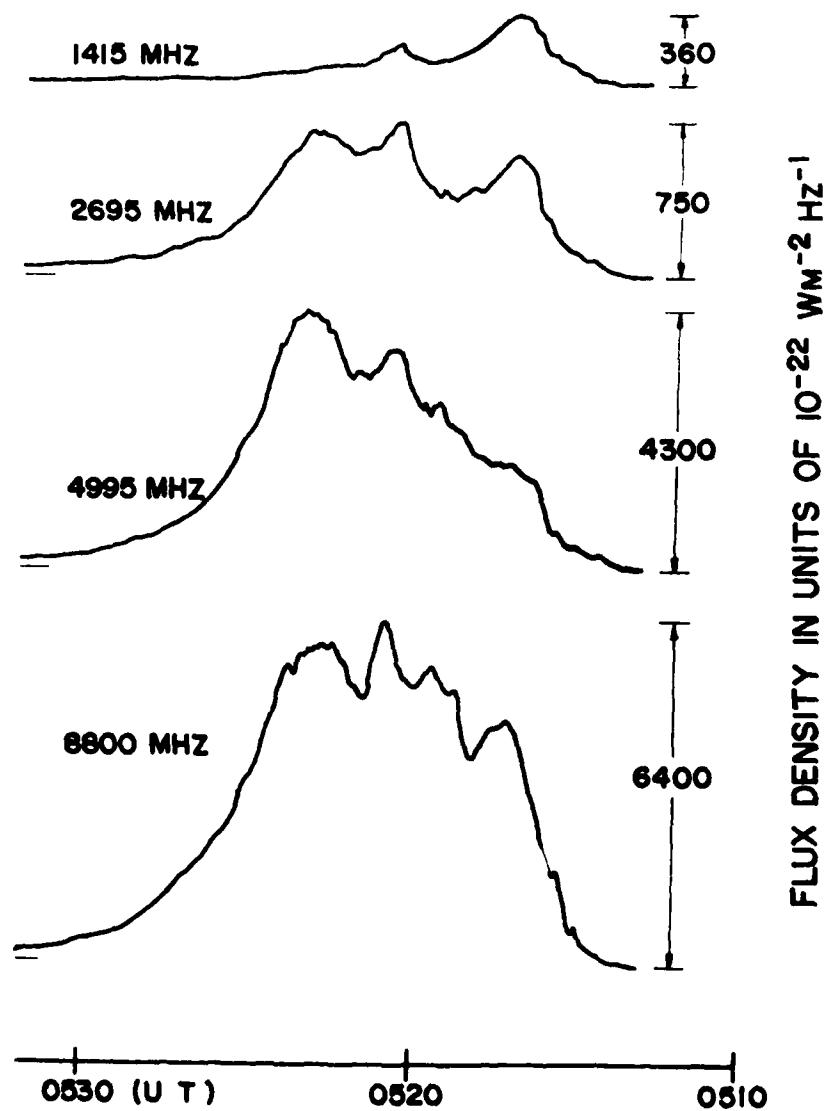
POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ Wm}^{-2} \text{ Hz}^{-1}$



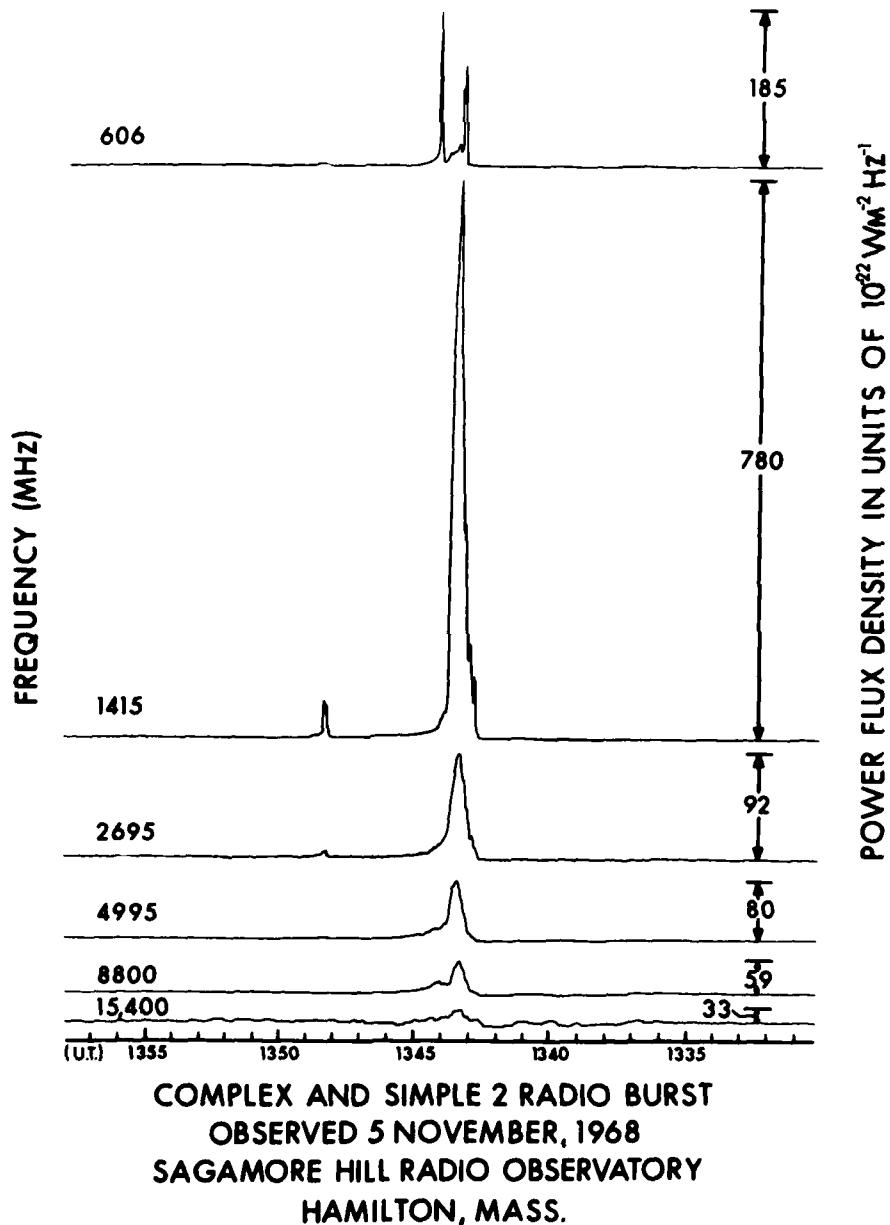
Complex with PBI Radio Burst Observed 31 October 1968 at Manila Radio Observatory

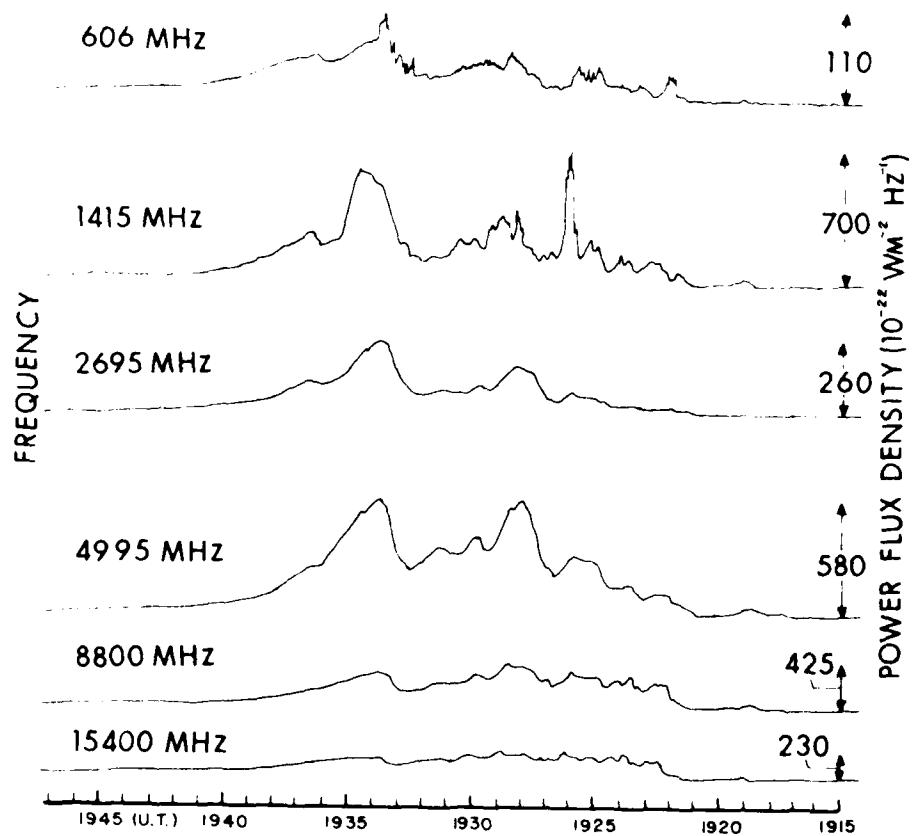


COMPLEX AND SIMPLE 2F RADIO BURST OBSERVED 1 NOV. 1968
AT SAGAMORE HILL RADIO OBSERVATORY - HAMILTON, MASS.



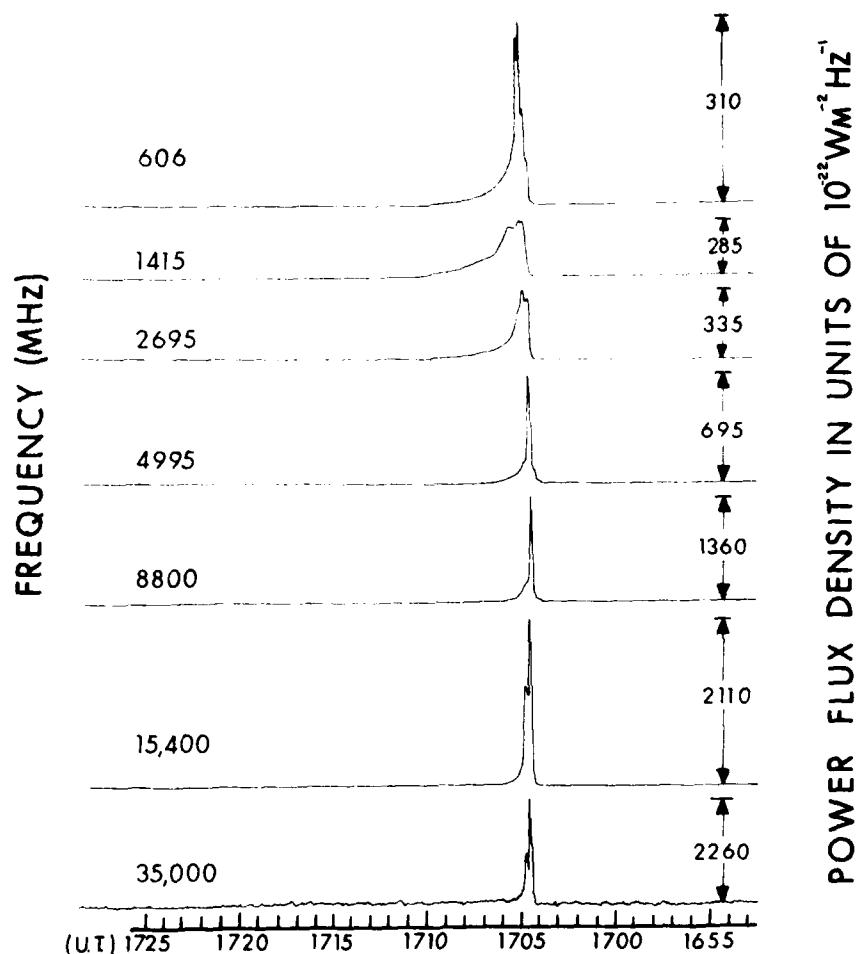
Complex with PBI Radio Burst Observed 4 November 1968
at Manila Radio Observatory



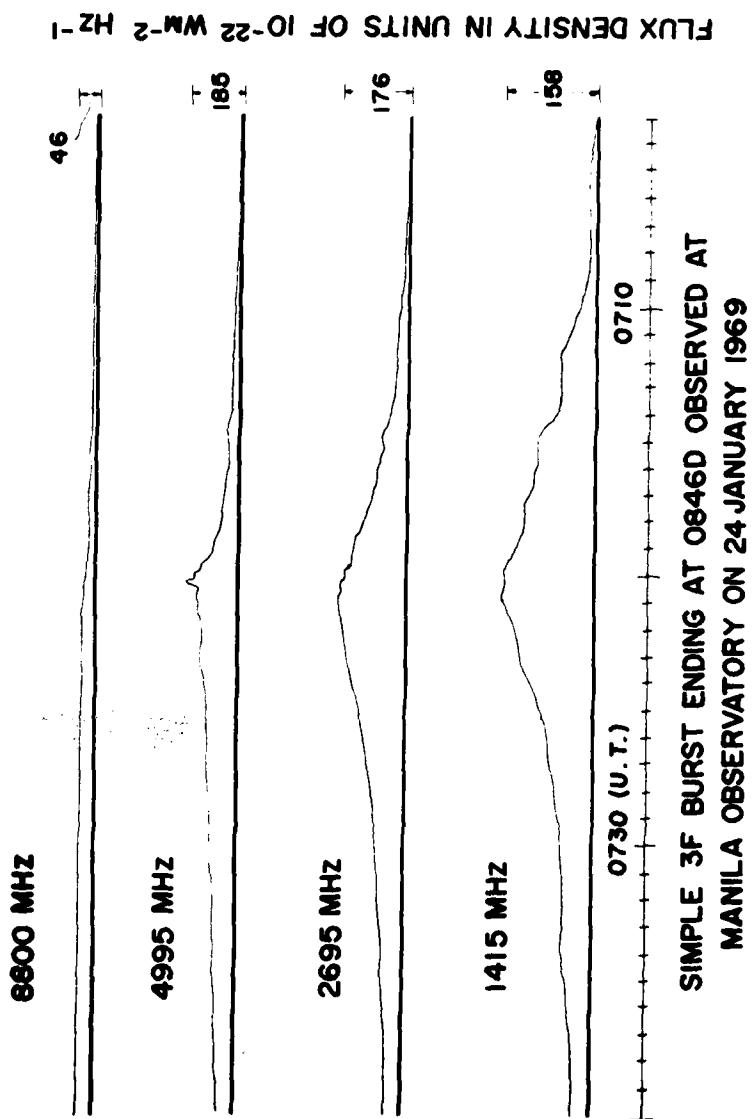


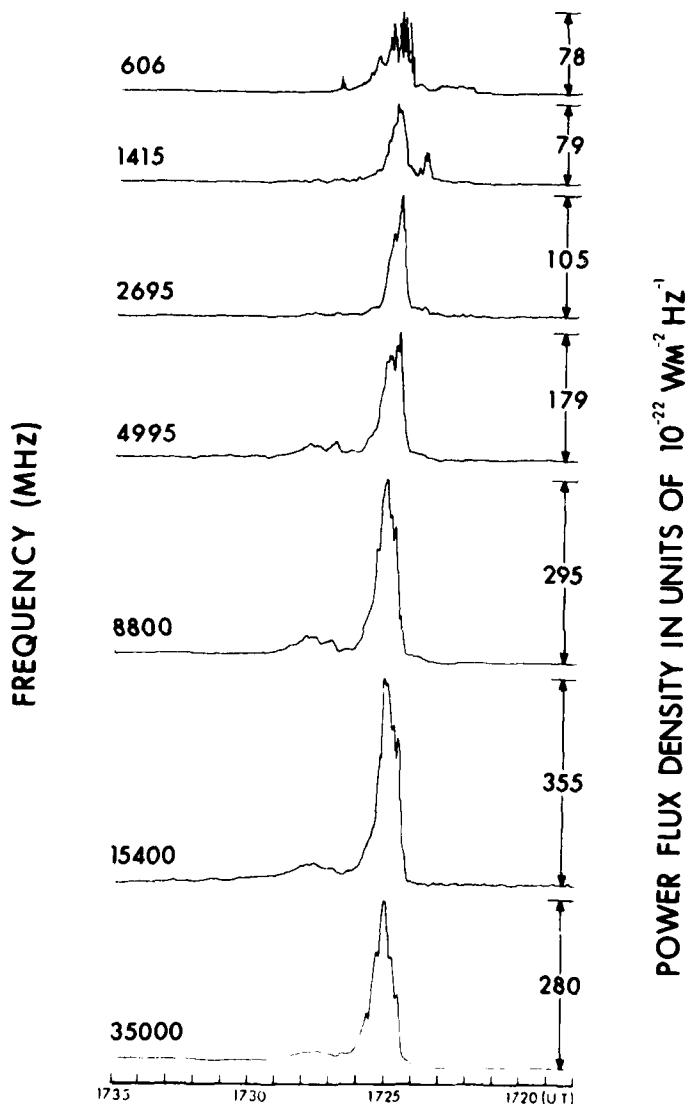
COMPLEX 'F' RADIO BURST-29 DECEMBER, 1968
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

**Solar Radio Bursts
1969**

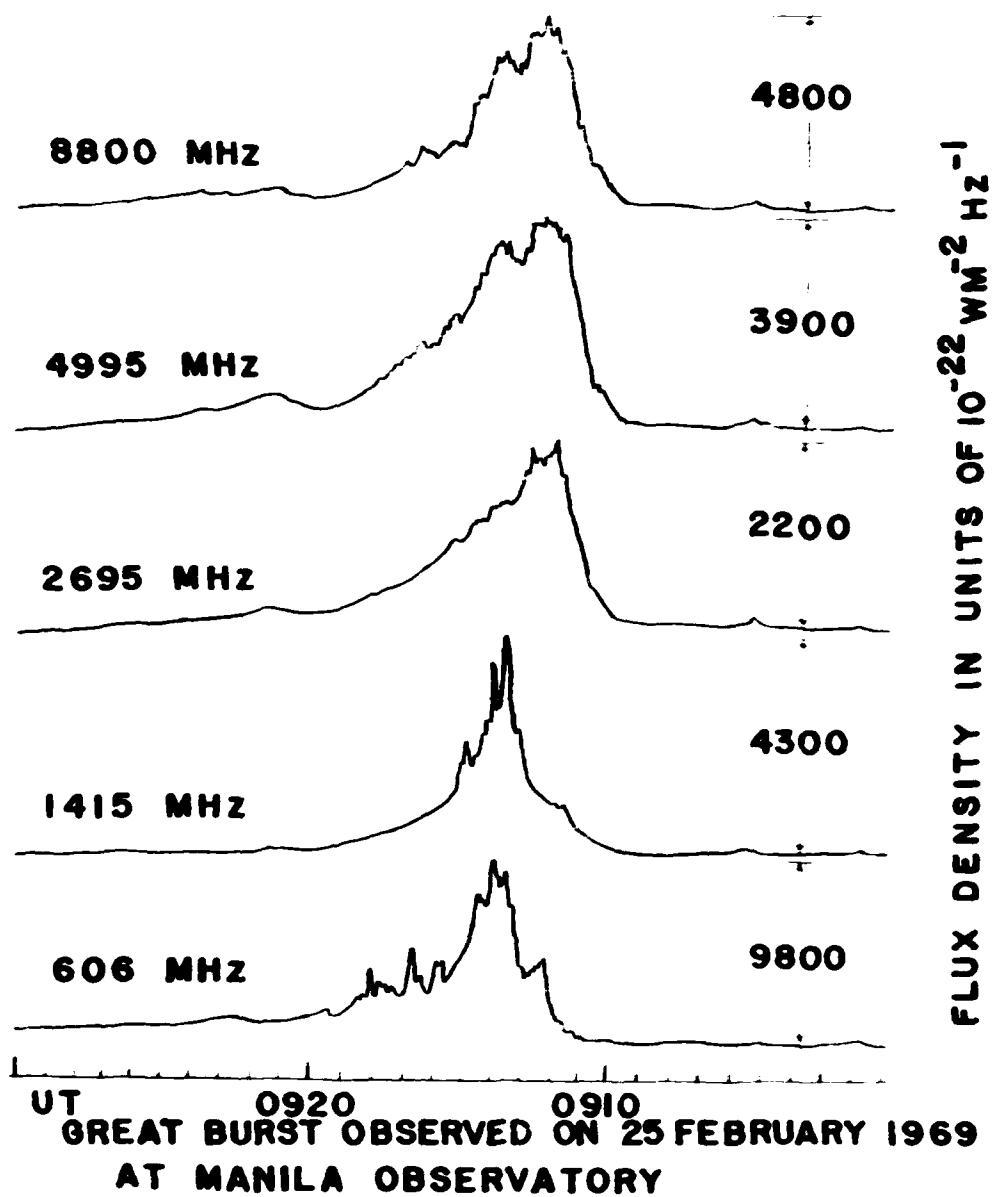


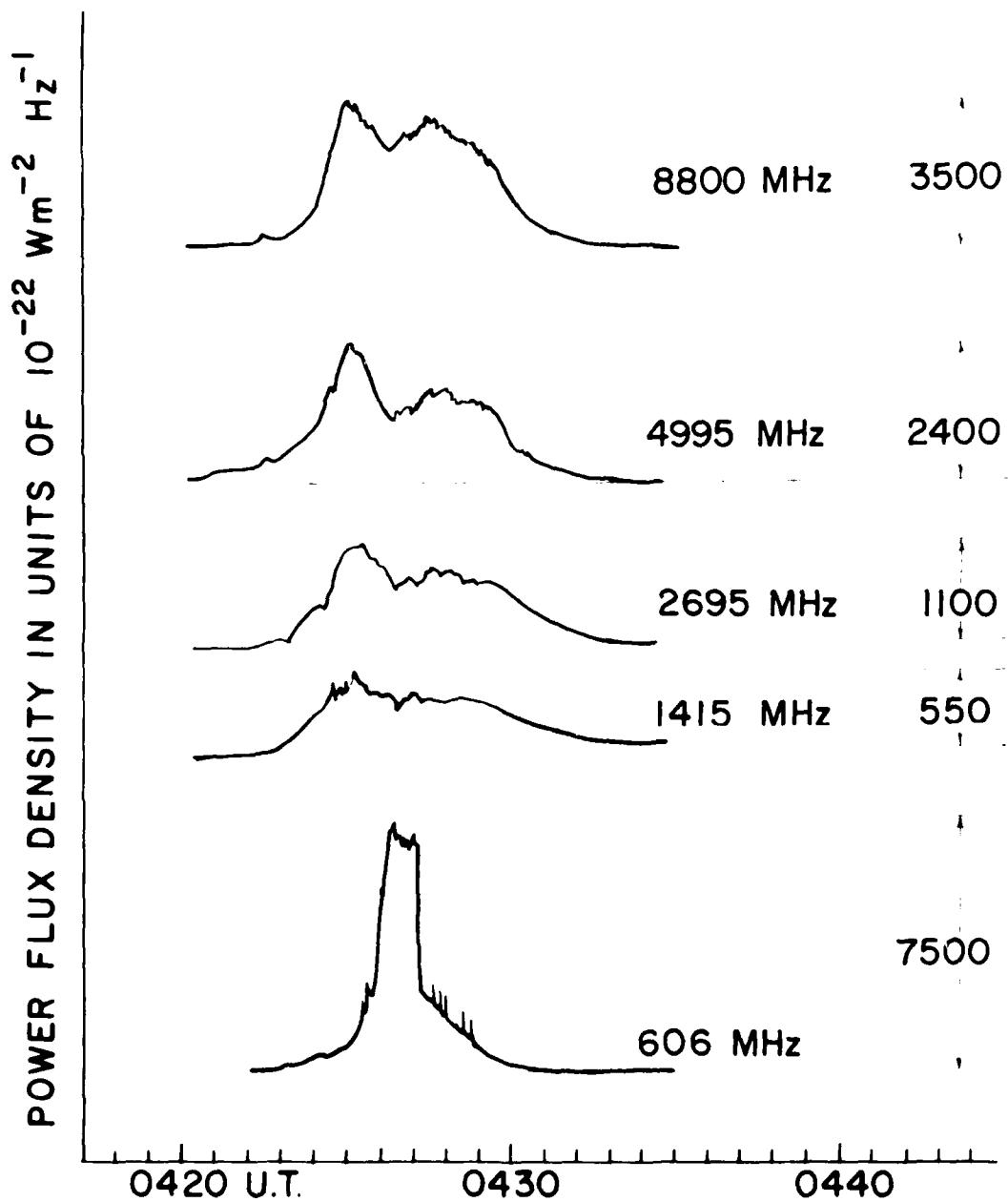
COMPLEX AND SIMPLE 2 RADIO BURST
OBSERVED 17 JANUARY, 1969
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

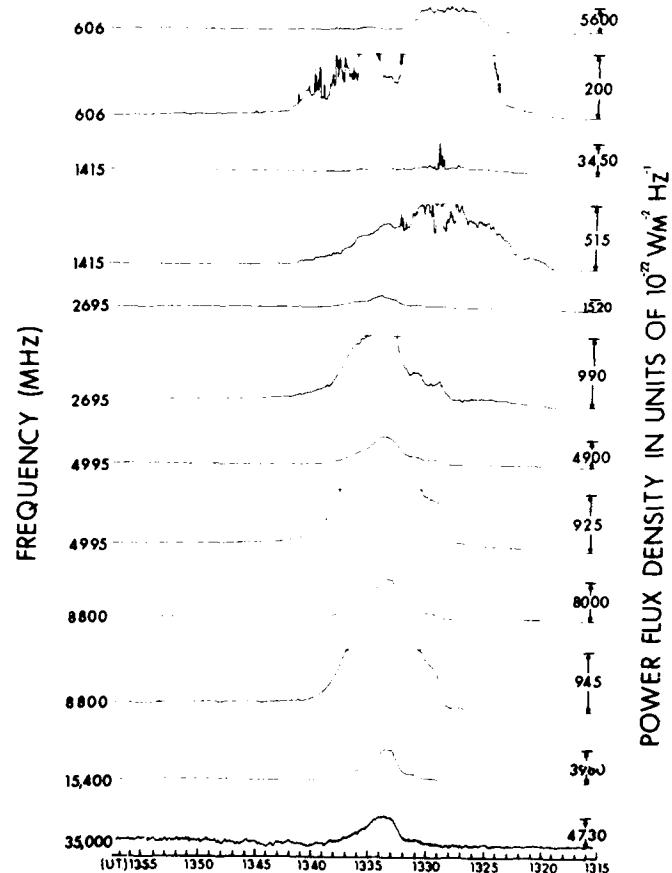




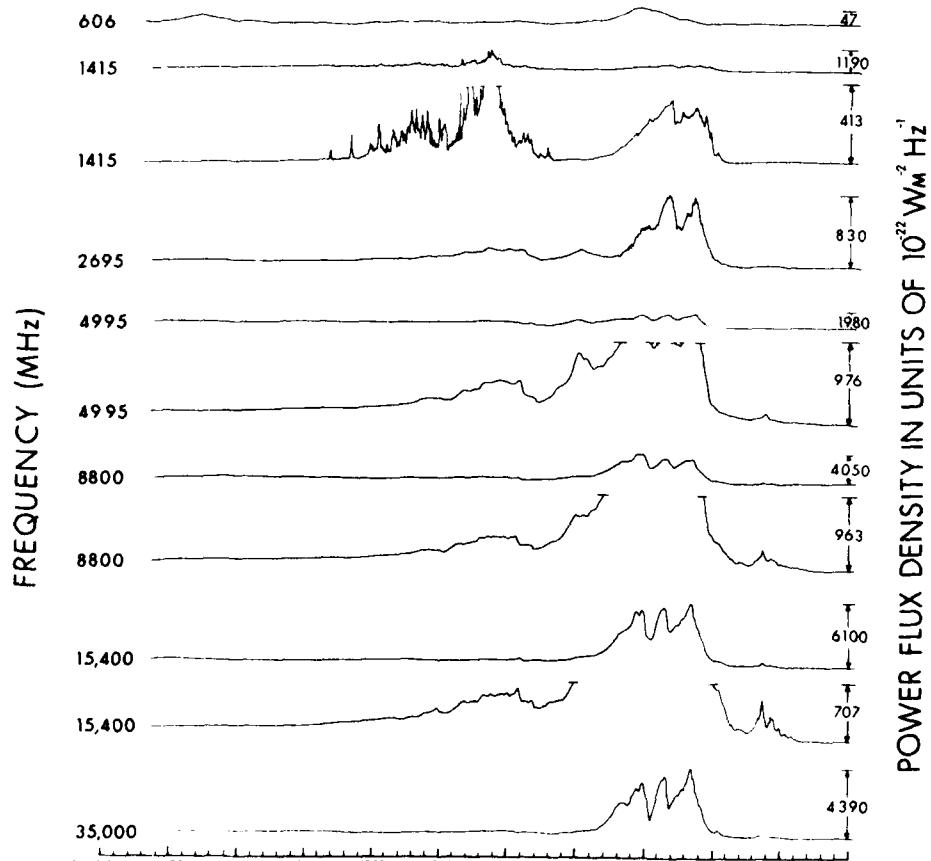
**SIMPLE 2 F AND COMPLEX F RADIO BURST
OBSERVED 9 FEBRUARY, 1969
AT SAGAMORE HILL RADIO OBSERVATORY
HAMMOND, MASS.**



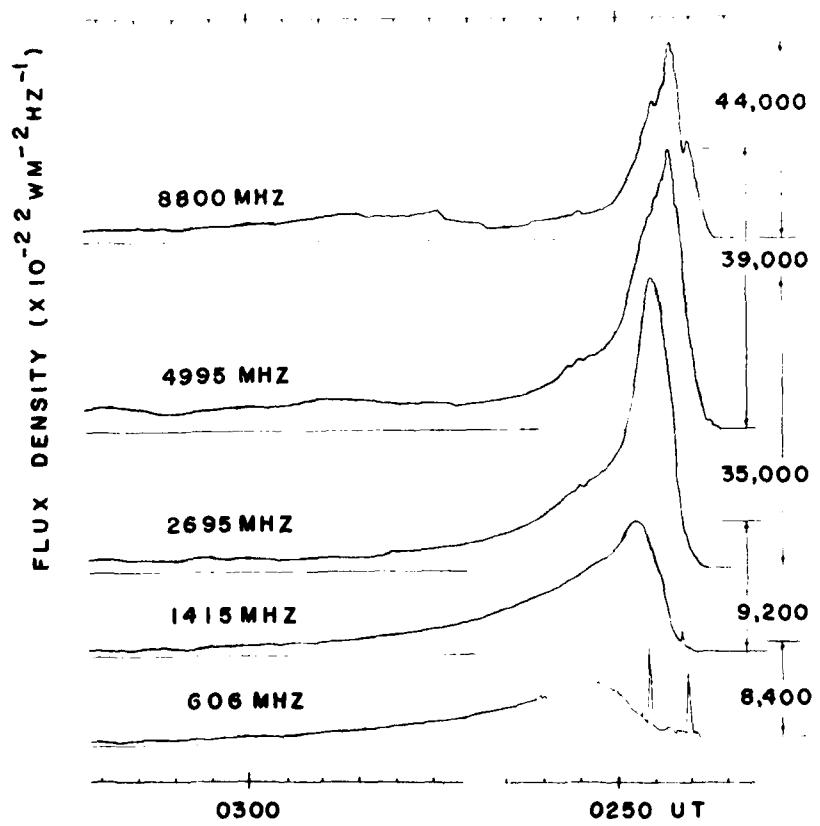




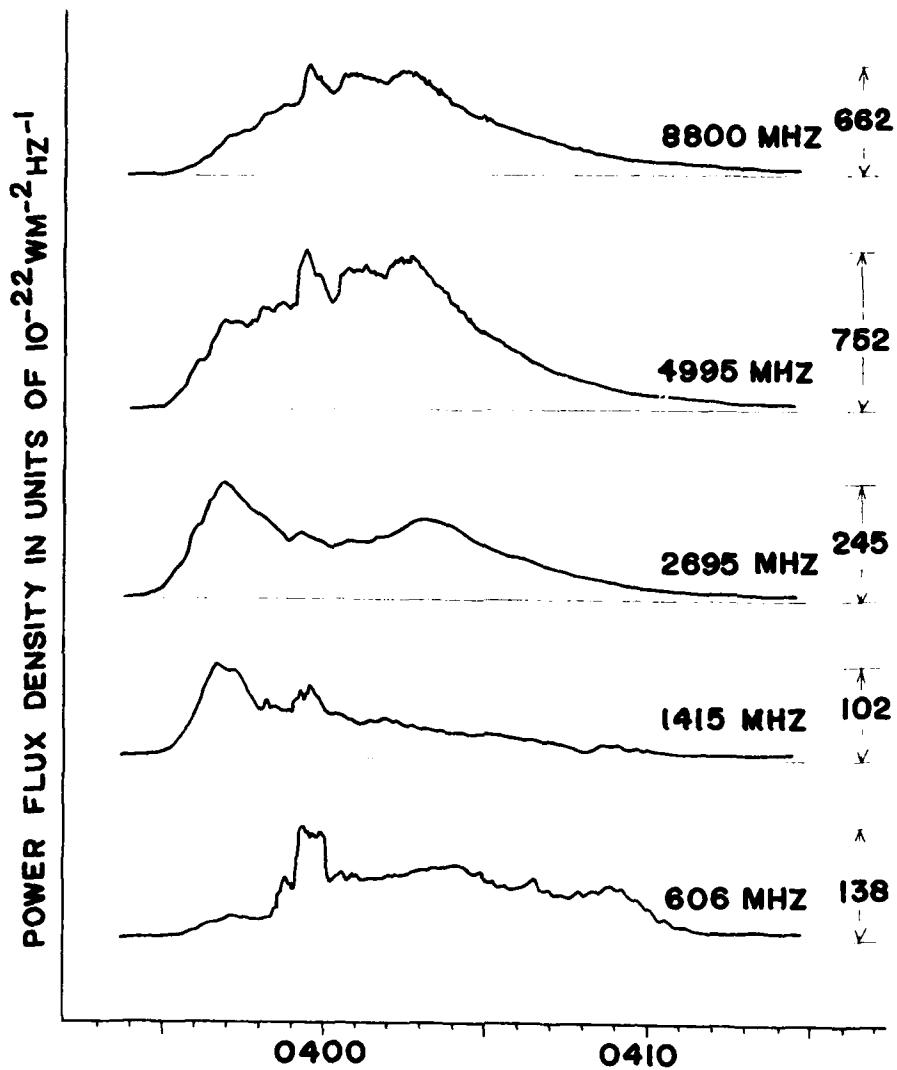
COMPLEX "F" & S2" RADIO BURST OBSERVED 21 MARCH, 1969
 AT SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.



COMPLEX F RADIO BURST OBSERVED 27 MARCH, 1969
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

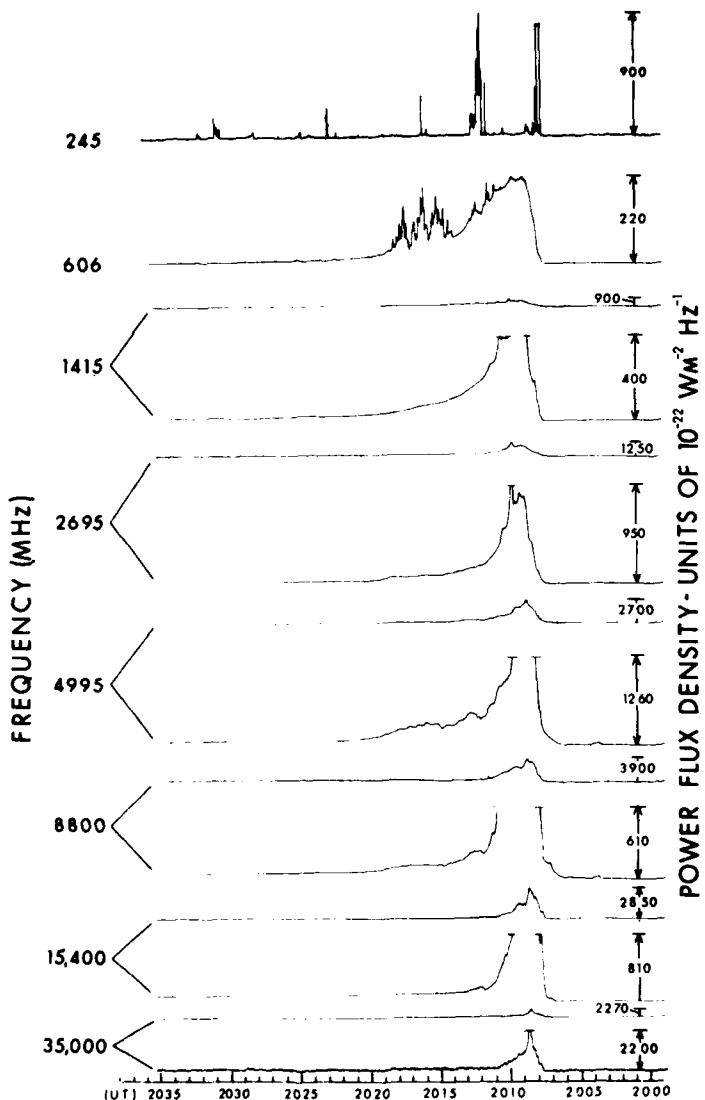


GREAT BURST OBSERVED ON 30 MARCH 1969
AT MANILA OBSERVATORY

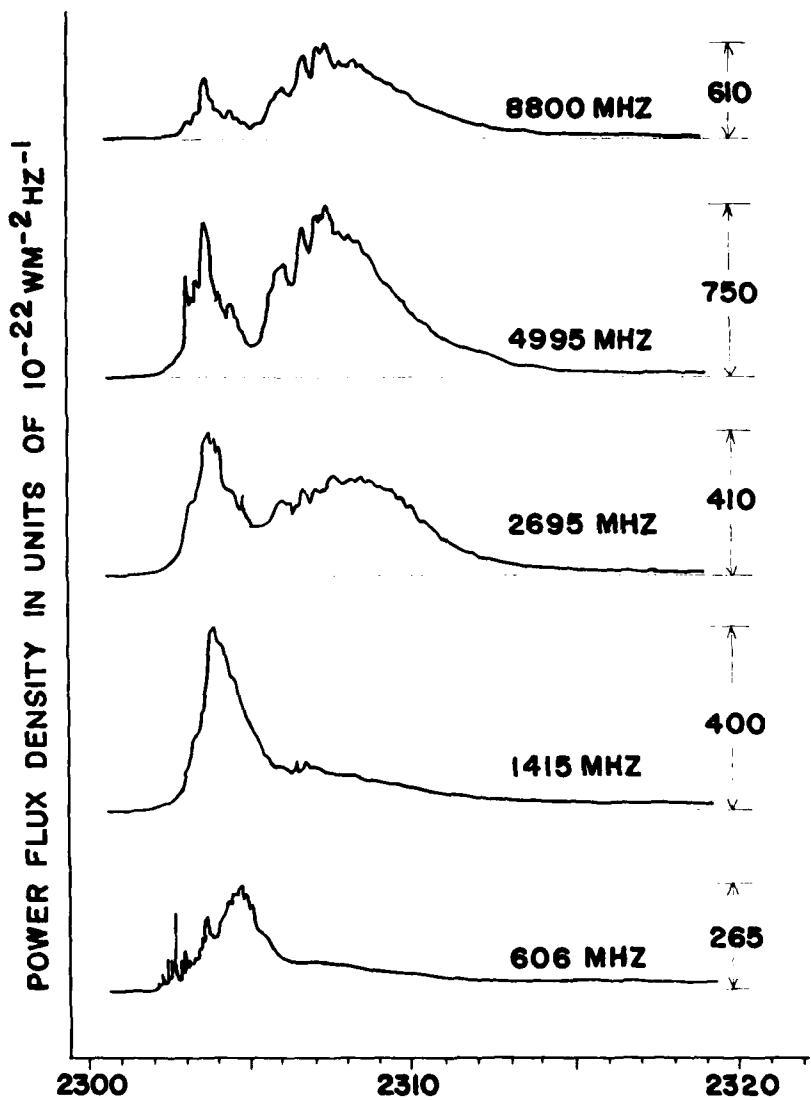


COMPLEX F RADIO BURST OBSERVED ON
10 APRIL 1969 AT MANILA OBSERVATORY

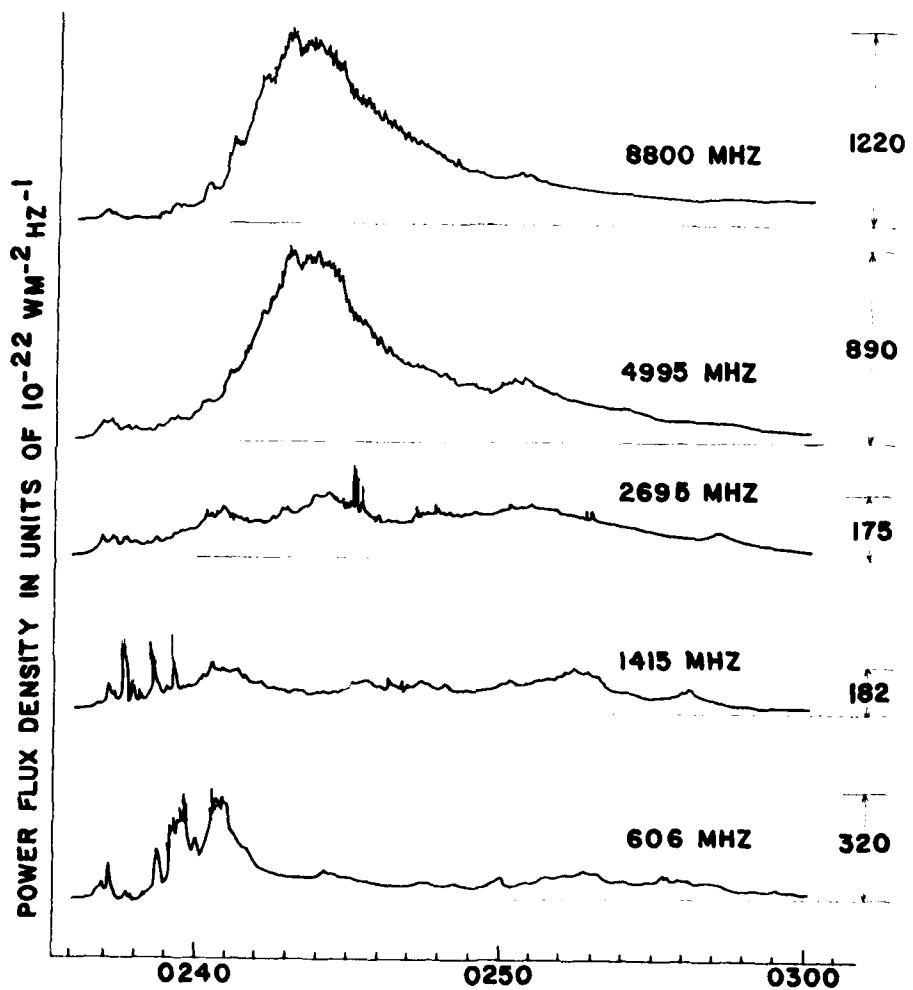
R. P.



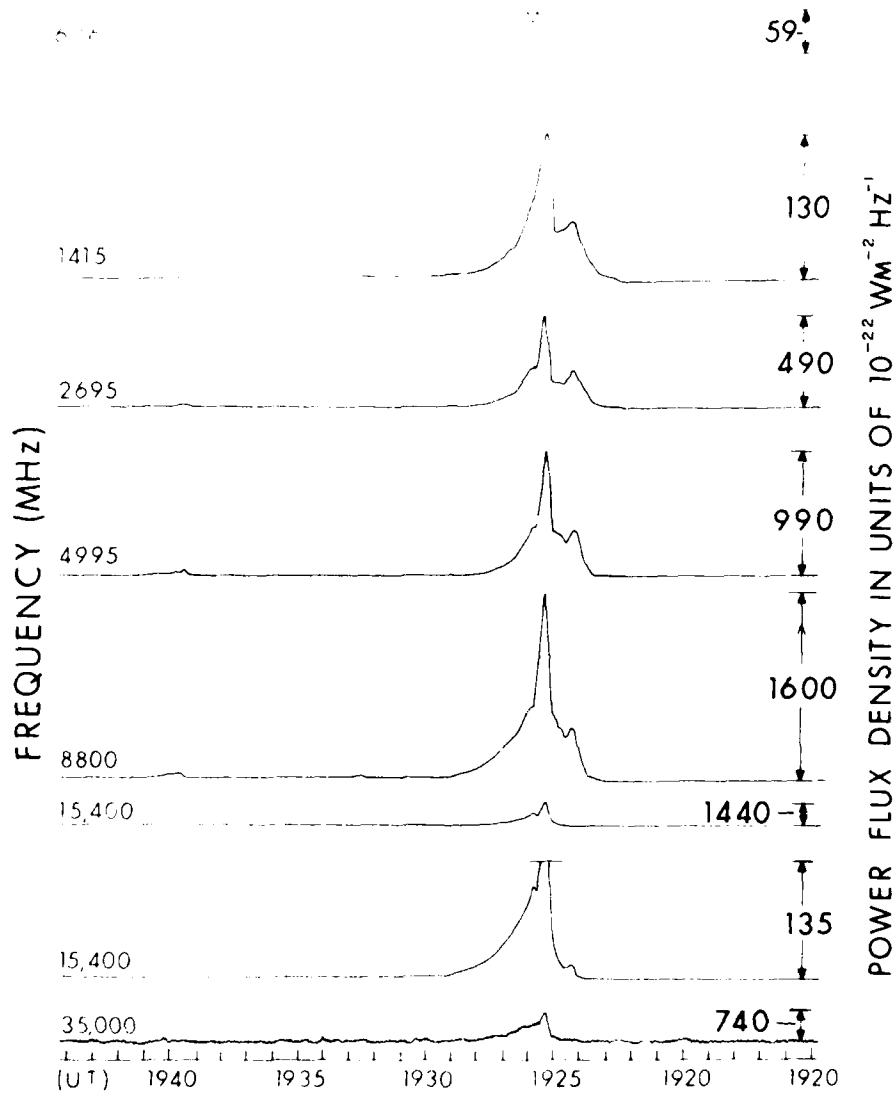
A COMPLEX RADIO BURST OBSERVED 21 APRIL, 1969
SAGAMORE HILL RADIO OBSERVATORY AT
HAMILTON, MASS.



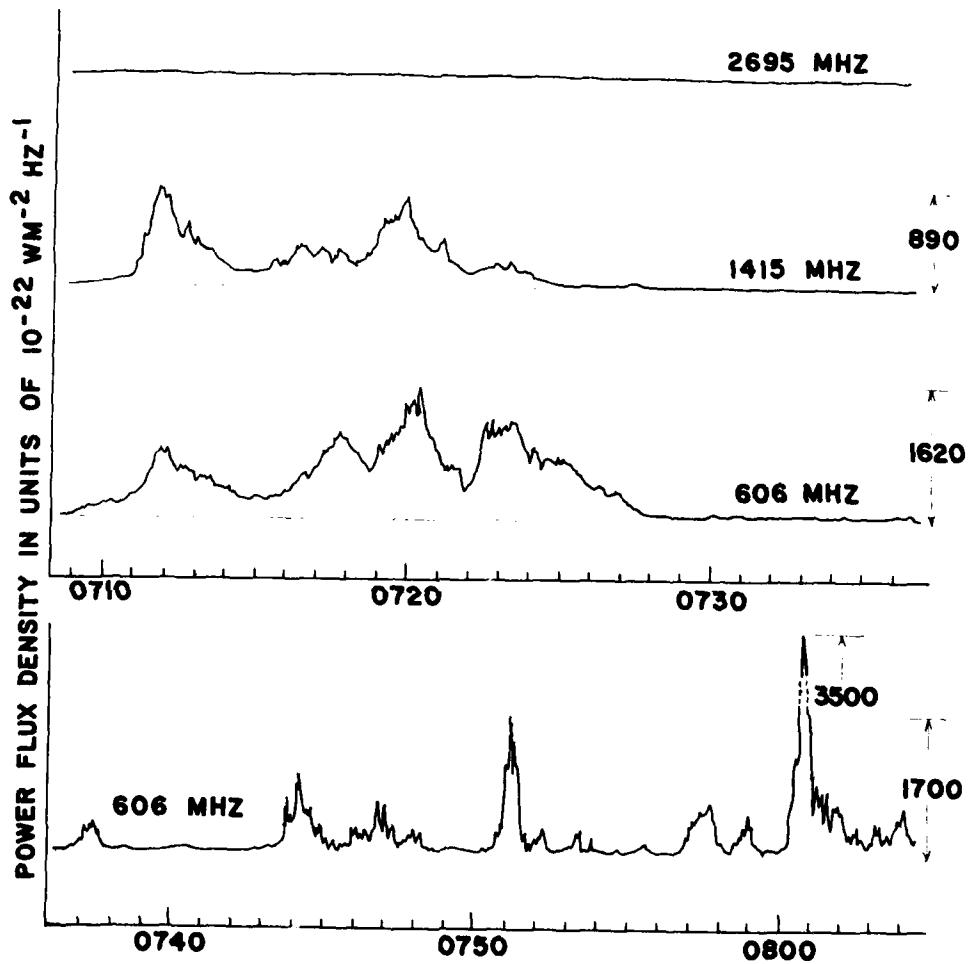
COMPLEX F & SIMPLE 2F RADIO BURSTS
OBSERVED ON 26 APRIL 1969 AT MANILA
OBSERVATORY, R. P.



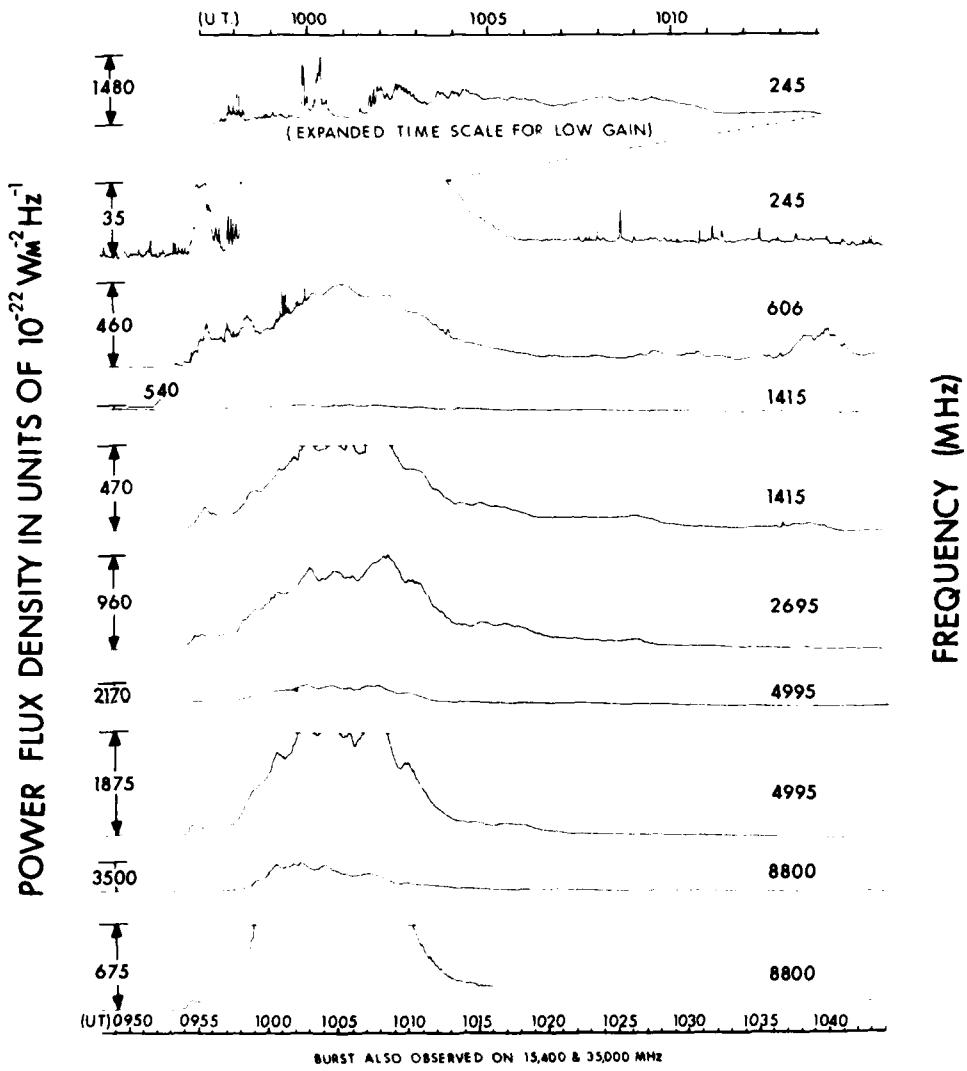
SIMPLE 2F & COMPLEX F RADIO BURSTS
 OBSERVED ON 6 MAY 1969 AT MANILA
 OBSERVATORY, R. P.



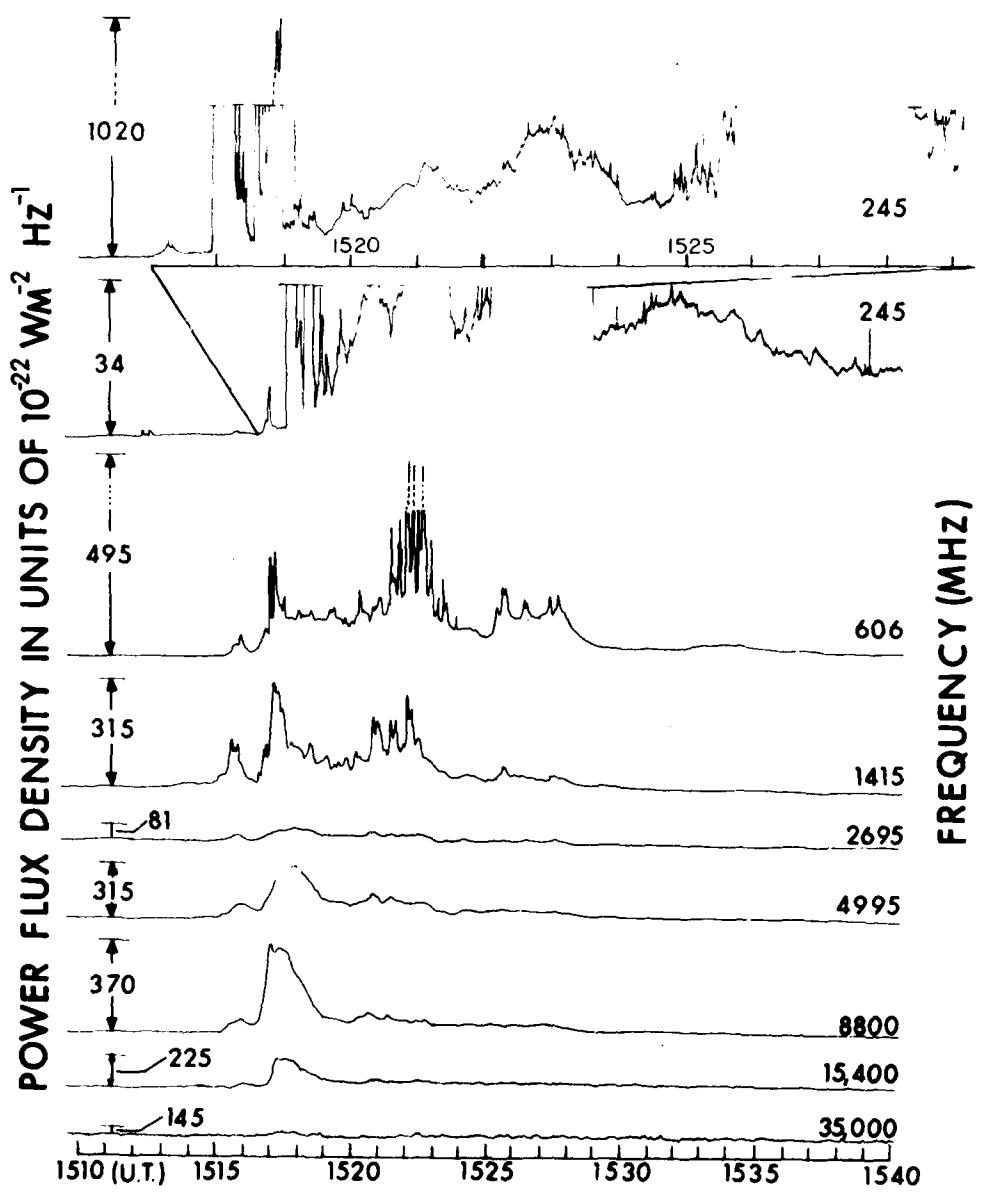
COMPLEX RADIO BURST OBSERVED ON 17 MAY, 1969
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.



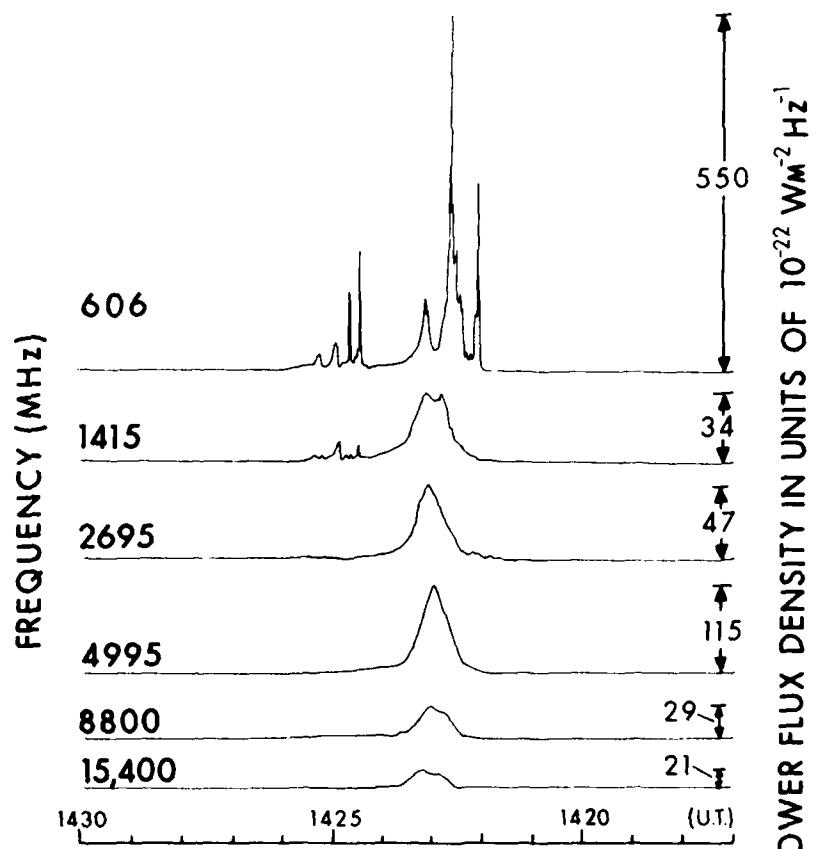
COMPLEX F RADIO BURST WITH HIGH FREQUENCY
CUT-OFF OBSERVED ON 24 MAY 1969 AT MANILA
OBSERVATORY, R. P.



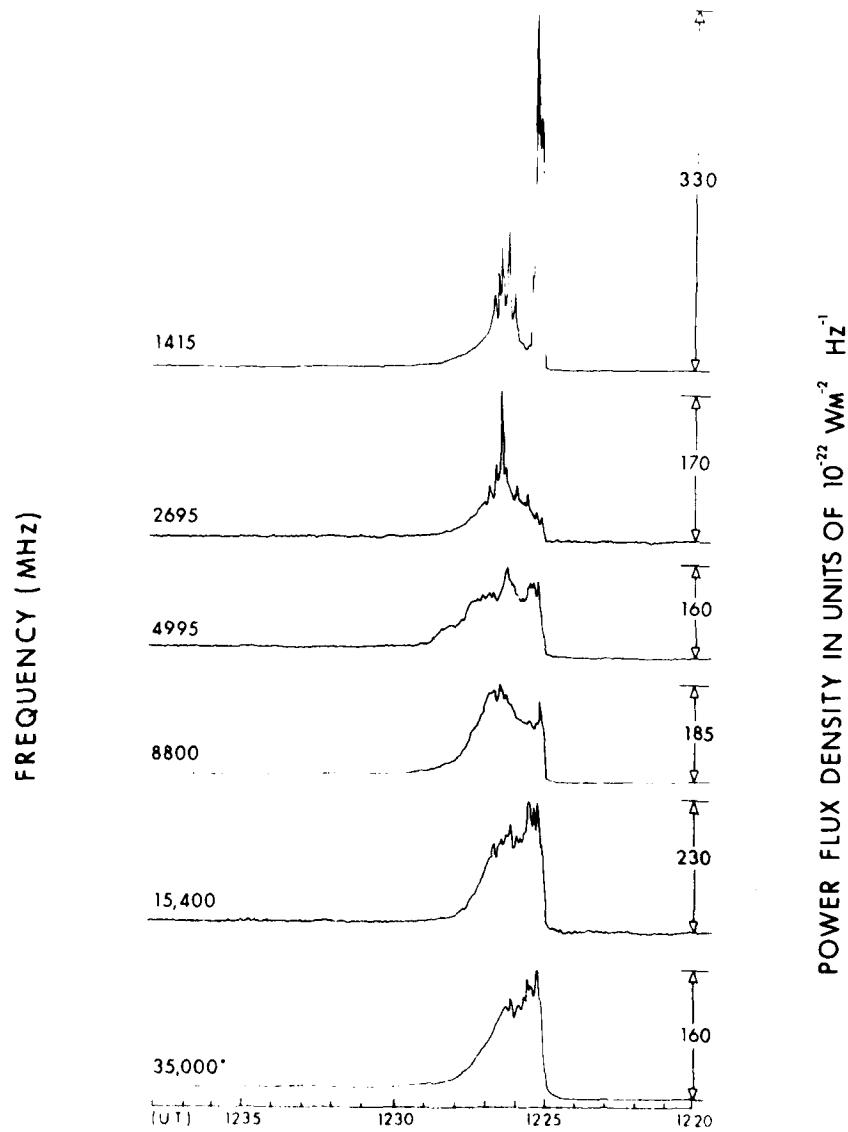
COMPLEX RADIO BURST OBSERVED 5 JUNE, 1969
AT SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.



SIMPLE 2 AND COMPLEX RADIO BURST 3 JULY, 1969
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.



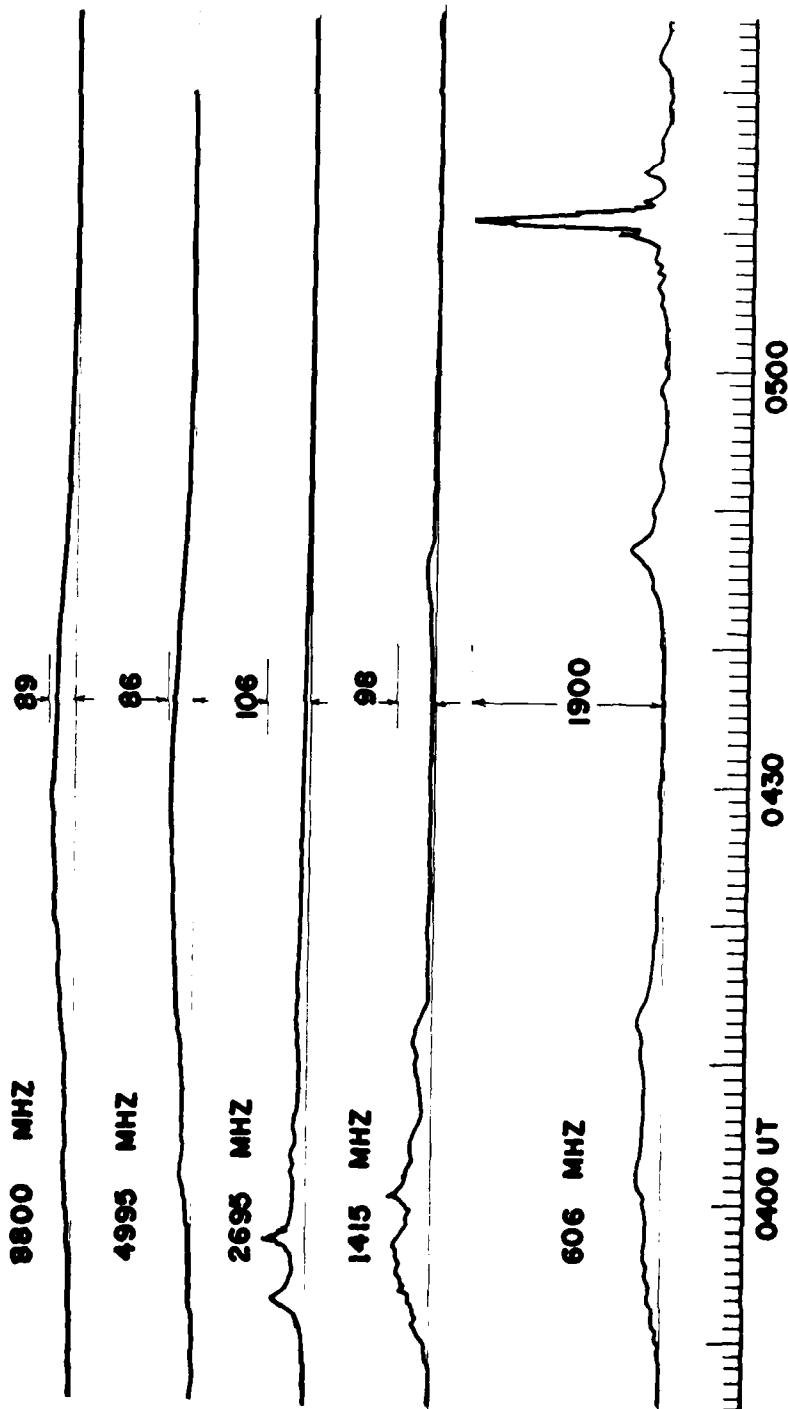
COMPLEX AND SIMPLE 2 RADIO BURST
OBSERVED ON 10 AUGUST, 1969 AT
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



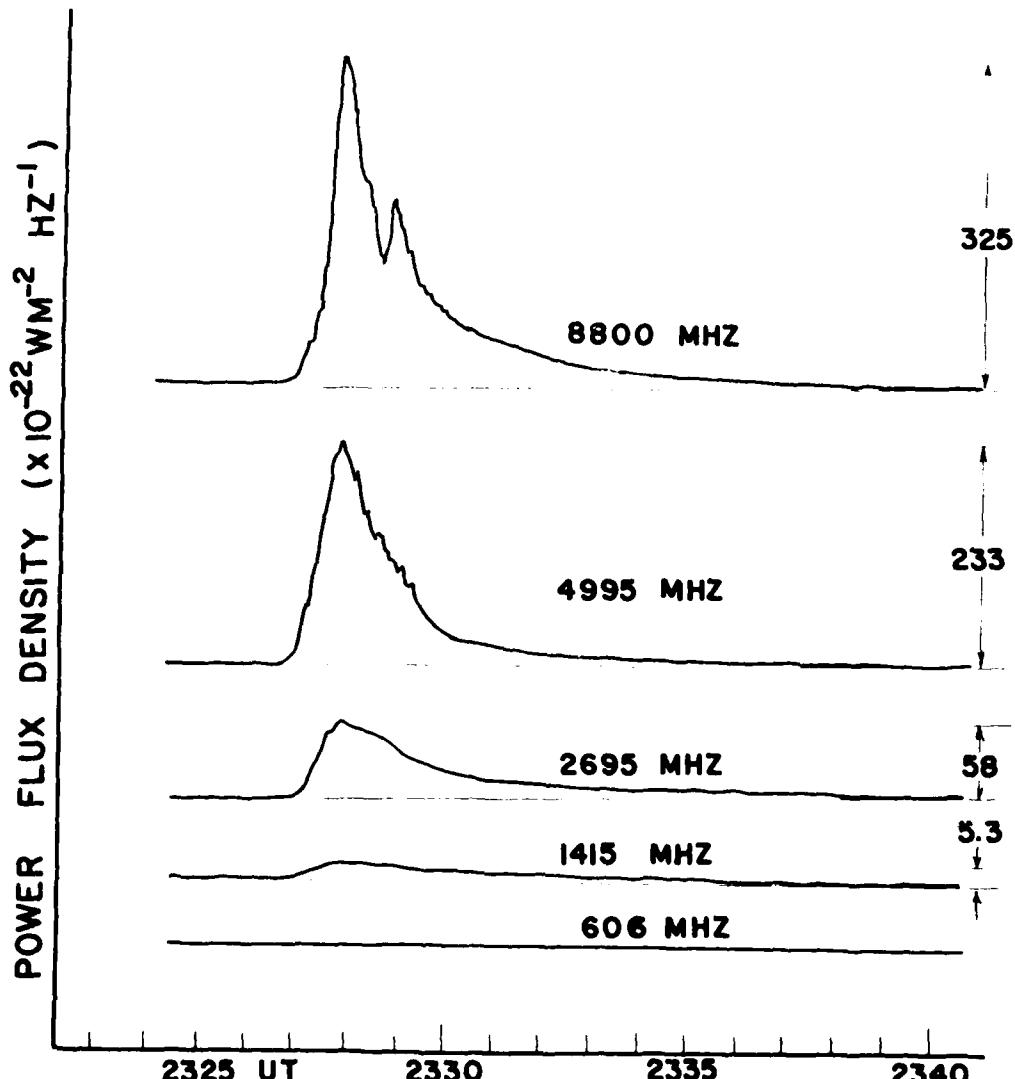
COMPLEX "F" AND SIMPLE 2 "F" RADIO BURST OBSERVED ON
 15 SEPT., 1969 AT SAGAMORE HILL RADIO OBSERVATORY AT
 HAMILTON, MASS.

*BURST RECONSTRUCTED

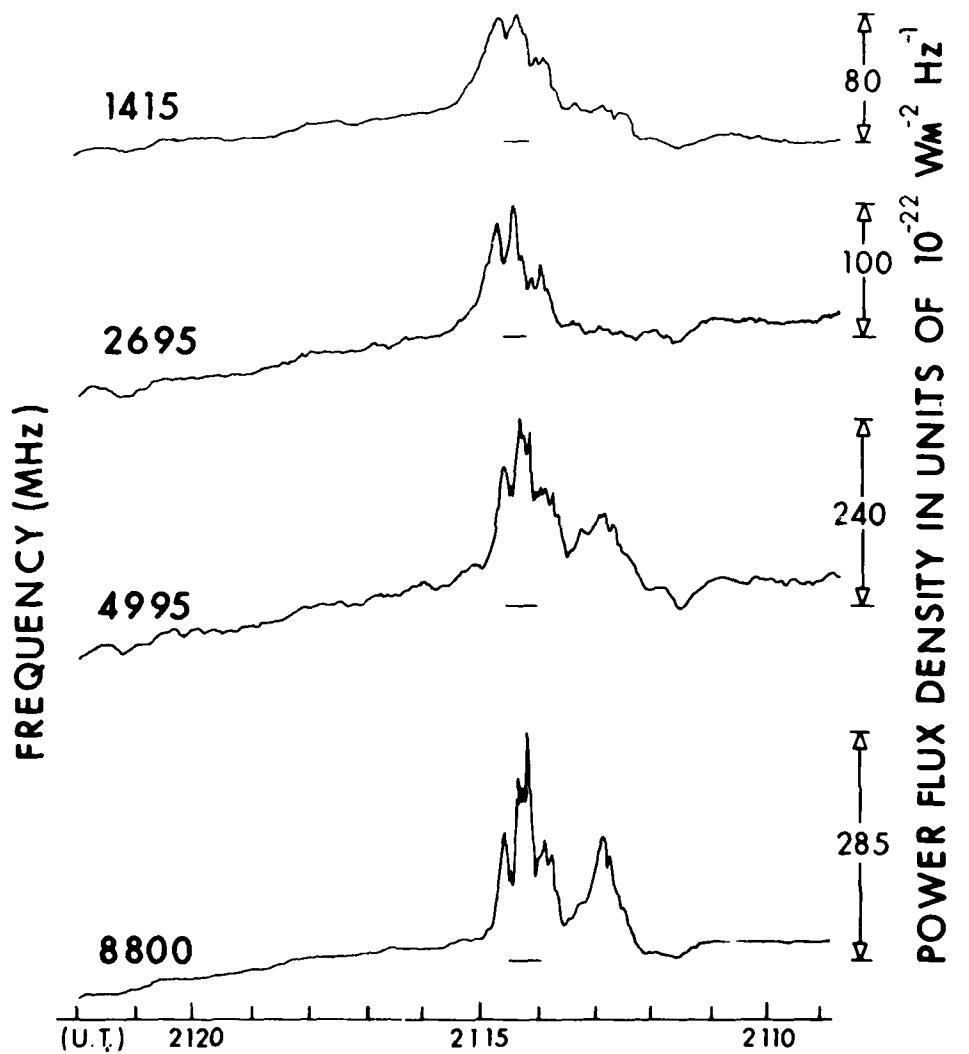
POWER FLUX DENSITY IN UNITS OF $10^{-22} \text{ WM}^{-2} \text{ Hz}^{-1}$



COMPLEX RADIO BURSTS ON 27 SEPTEMBER 1969
OBSERVED AT MANILA OBSERVATORY, R. P.



RADIO BURST OBSERVED
ON 11 OCTOBER, 1969
AT MANILA OBSERVATORY



**COMPLEX F RADIO BURST OBSERVED ON
24 OCTOBER, 1969
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS**

(NOTE: SUNSET TIME 2143 U.T.)

AD-A088 220

AIR FORCE GEOPHYSICS LAB HANSCOM AFB MA
AN ATLAS OF SELECTED MULTI-FREQUENCY RADIO BURSTS FROM THE TWEN--ETC(U)
APR 80 W R BARRON, V L BADILLO, E W CLIVER

F/8 3/2

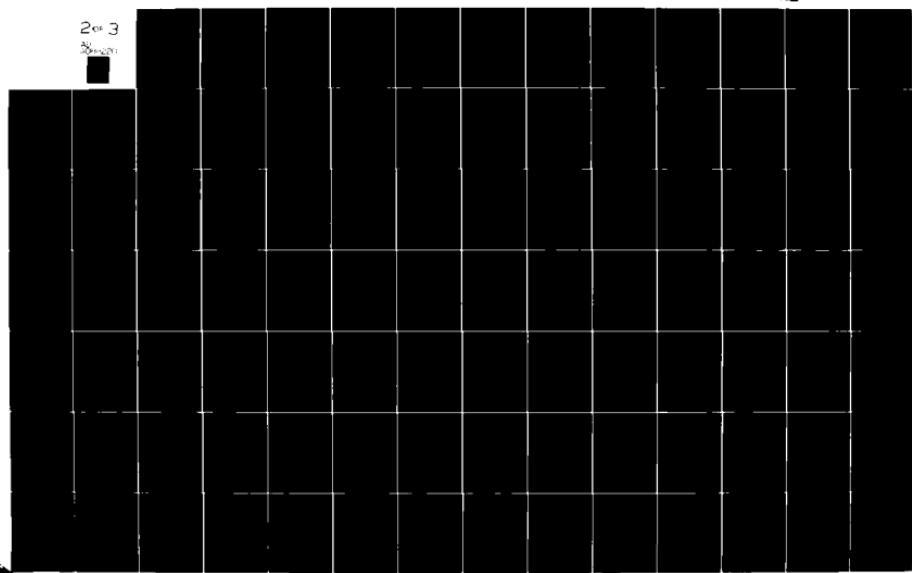
UNCLASSIFIED

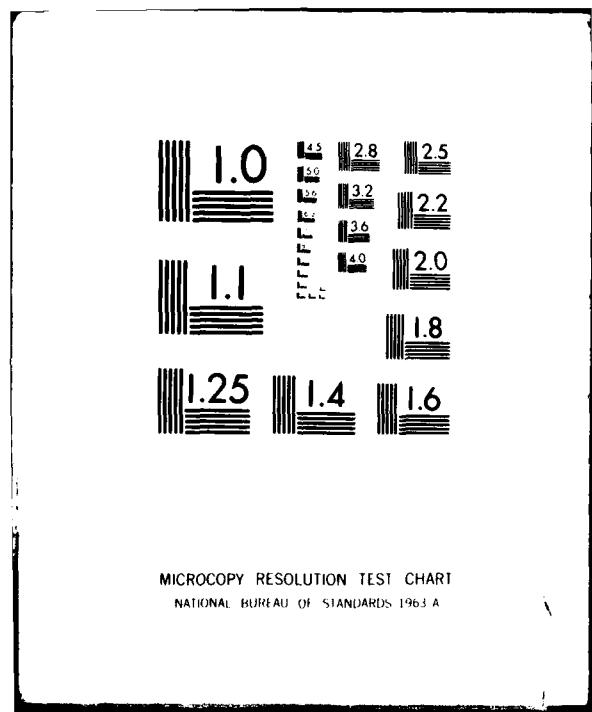
AFGL-TR-80-0098

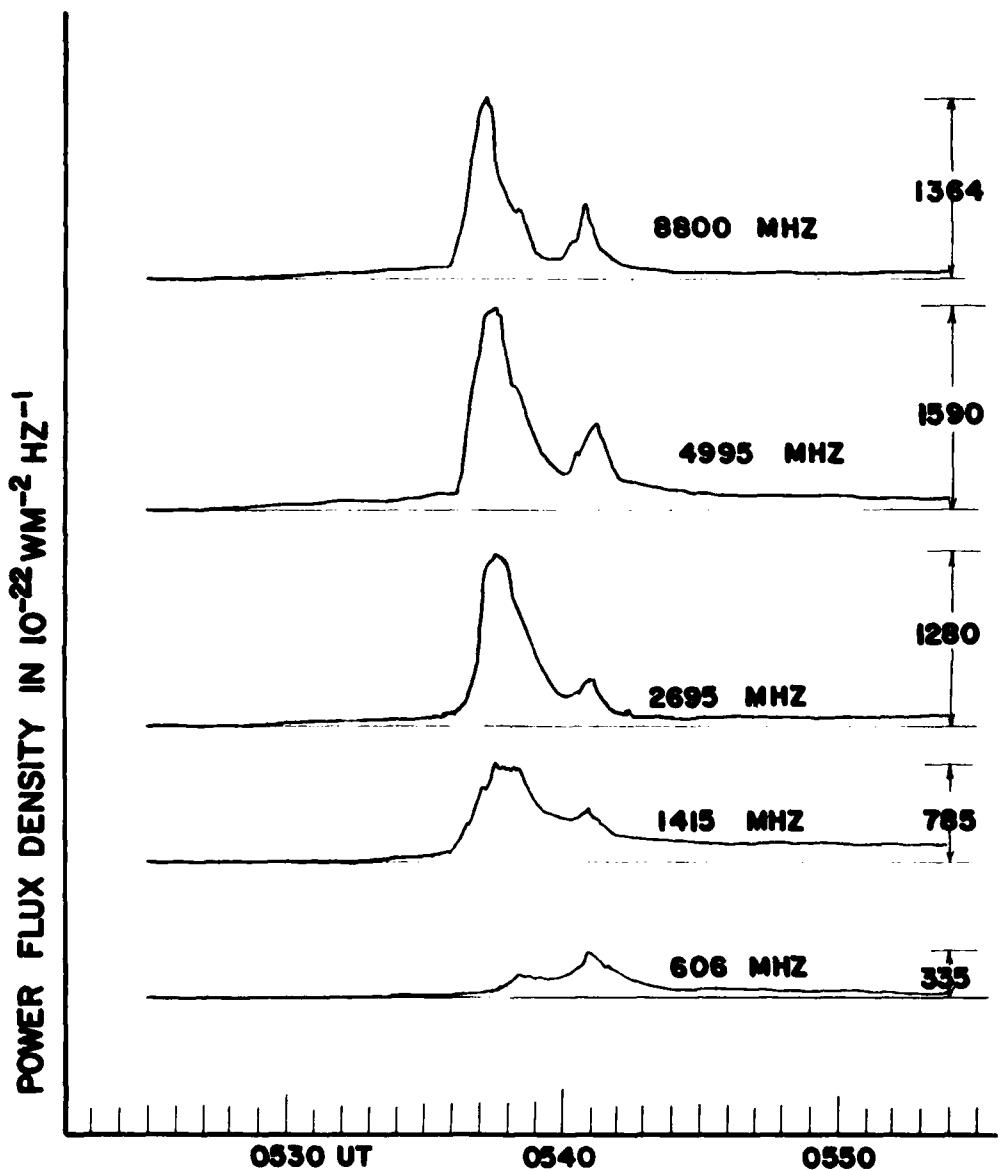
NL

2e3

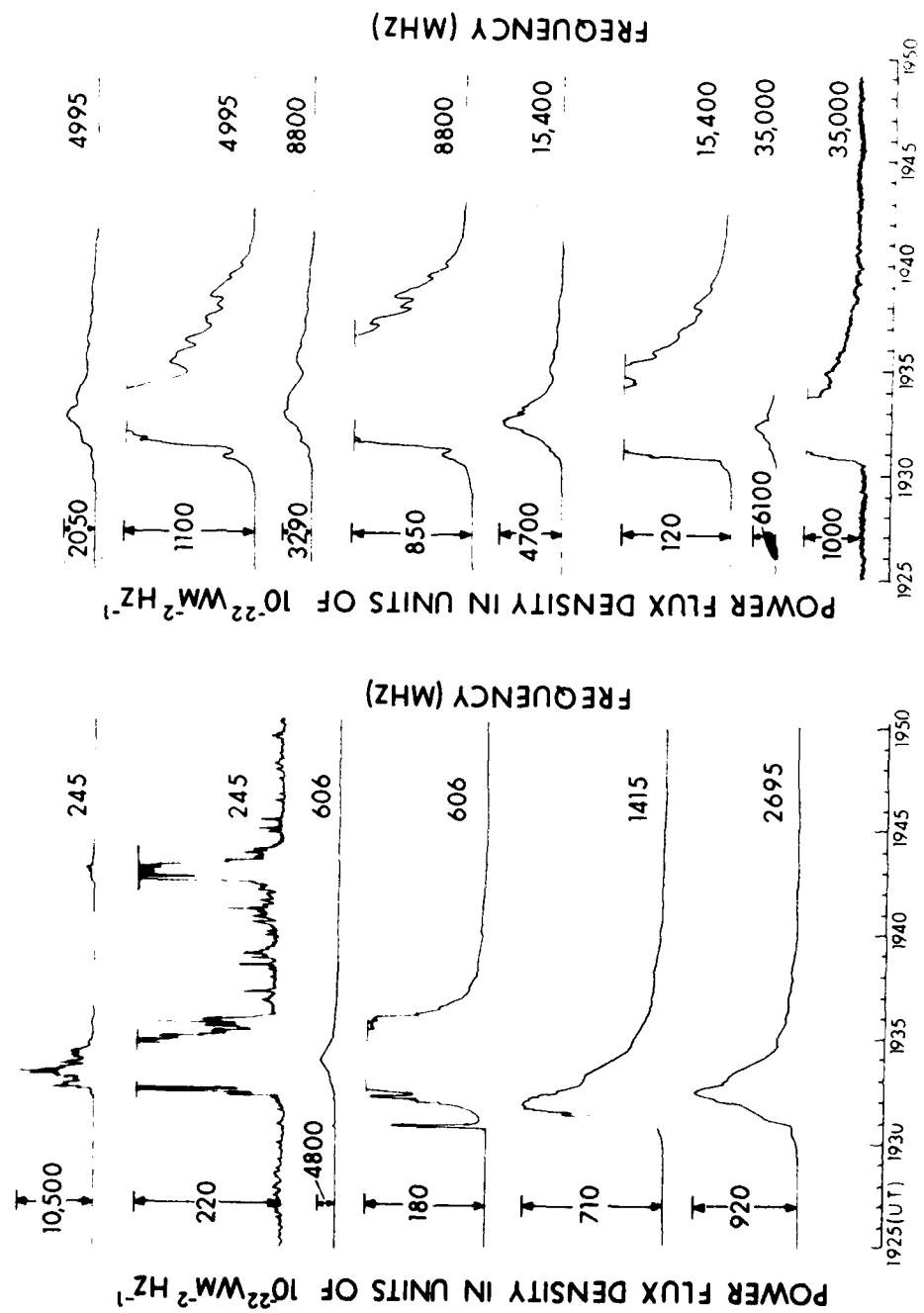
2e3



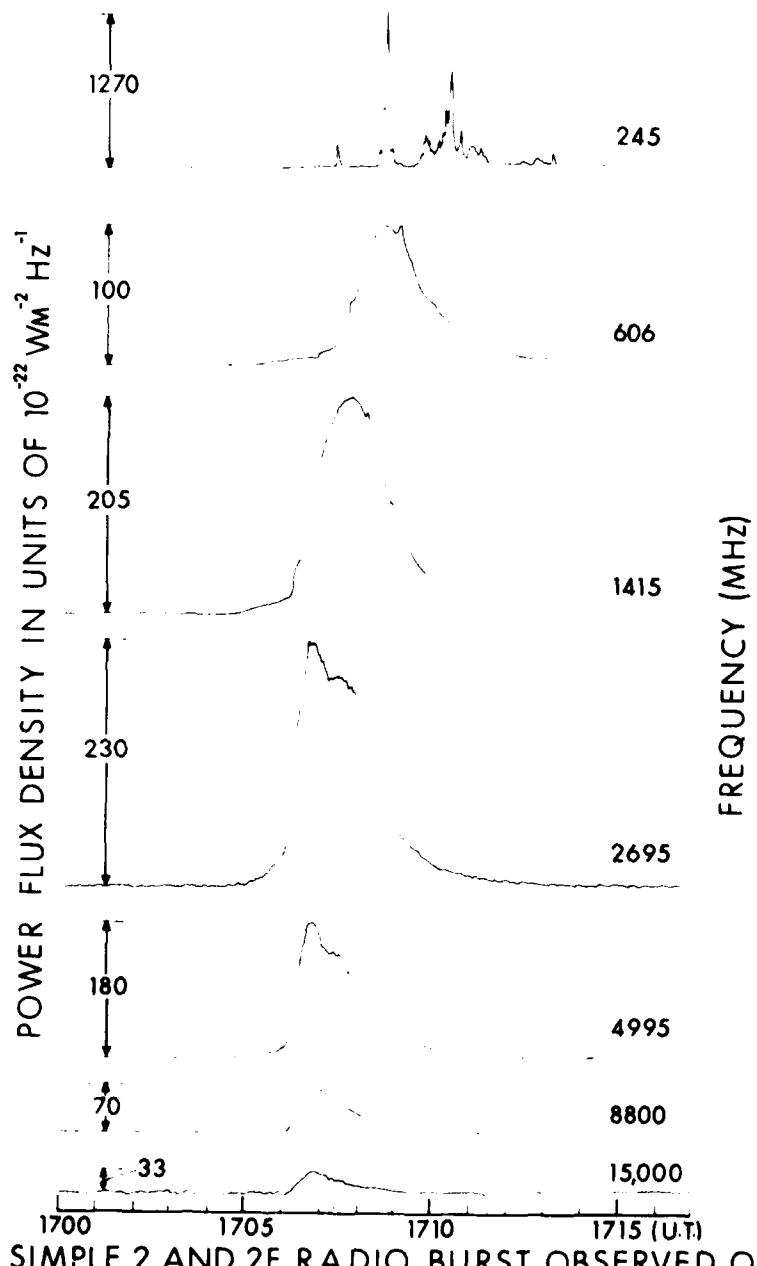




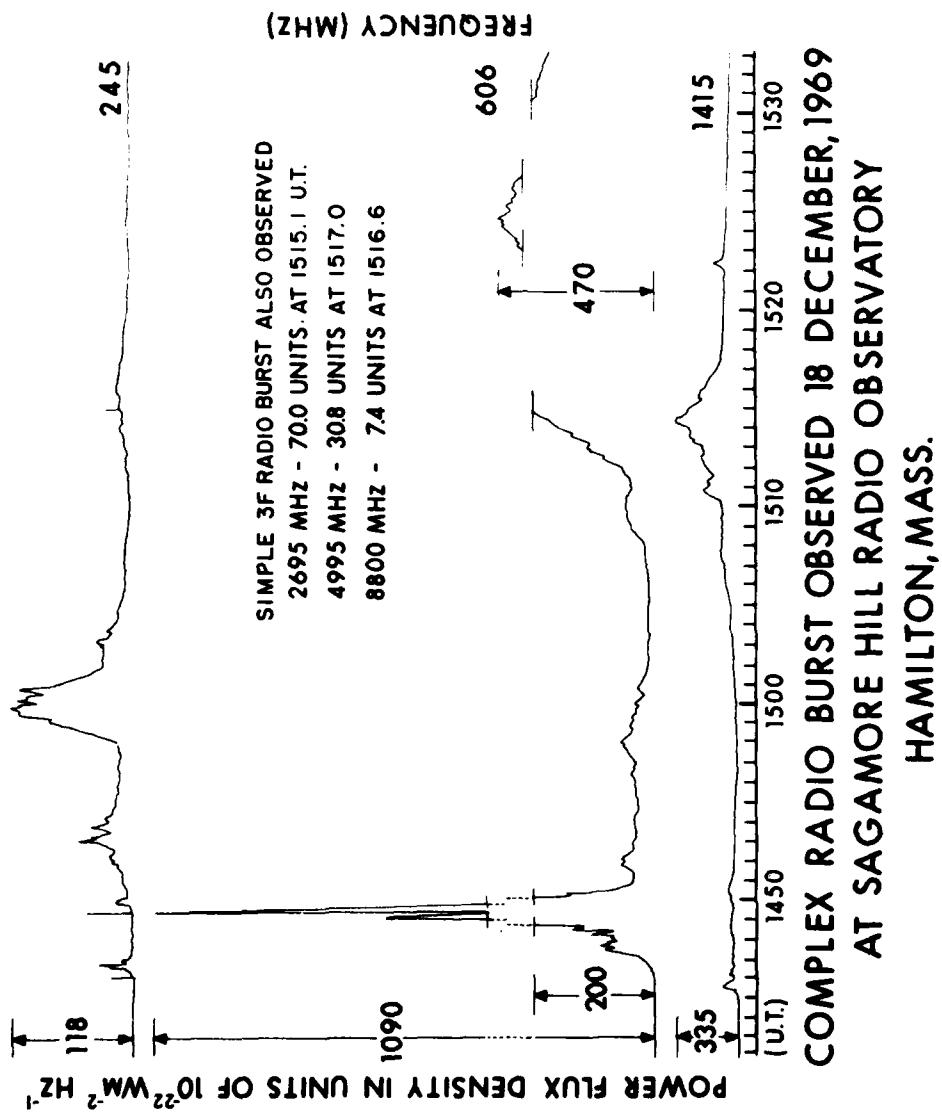
GREAT RADIO BURST PBI LASTED 60 MINUTES
OBSERVED ON 19 NOVEMBER, 1969 AT
MANILA OBSERVATORY

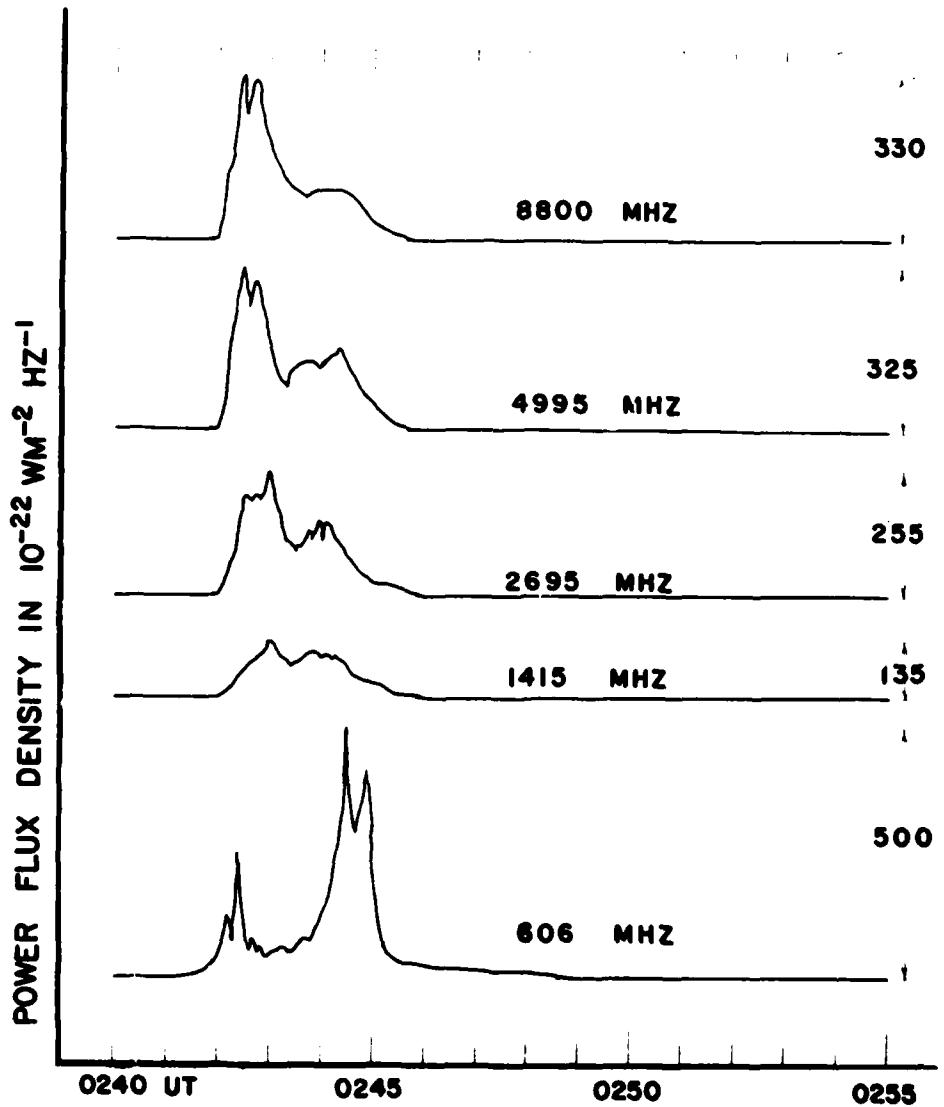


**GREAT BURST OBSERVED 27 NOVEMBER, 1969 AT SAGAMORE HILL
RADIO OBSERVATORY, HAMILTON, MASS.**



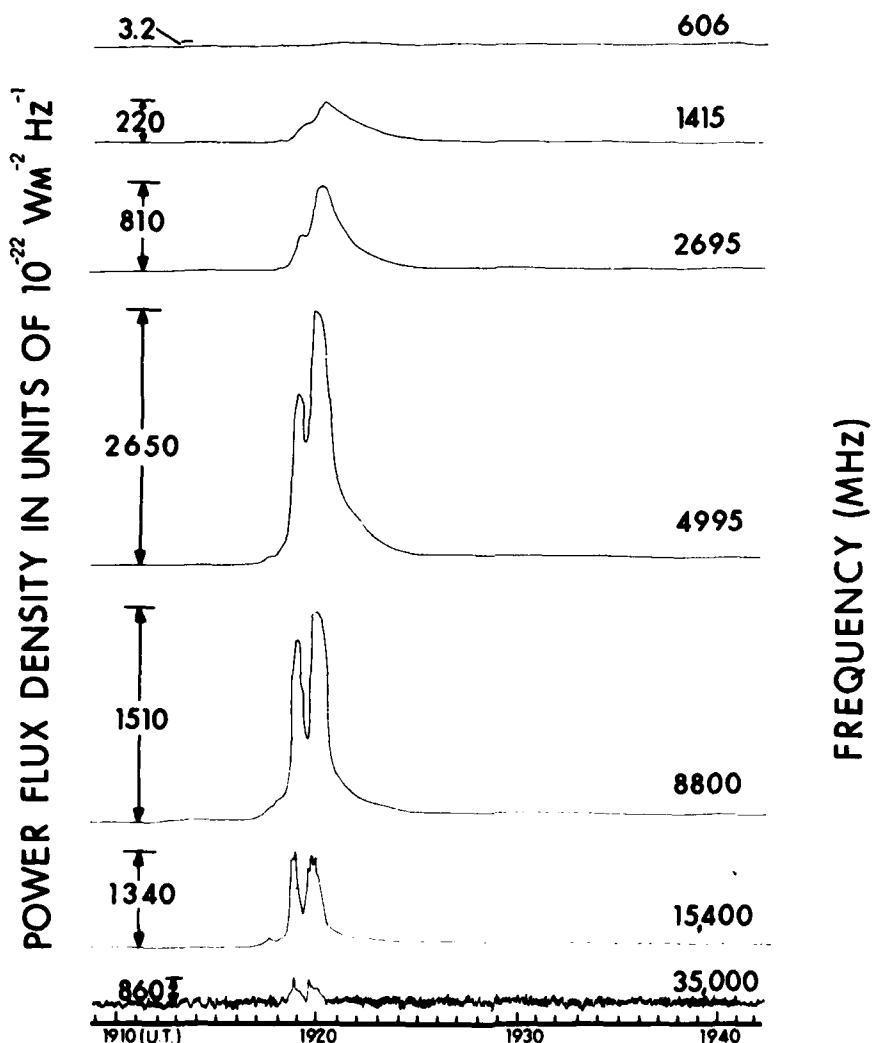
SIMPLE 2 AND 2F RADIO BURST OBSERVED ON
30 NOVEMBER, 1969
AT SAGAMORE HILL RADIO OBSERVATORY



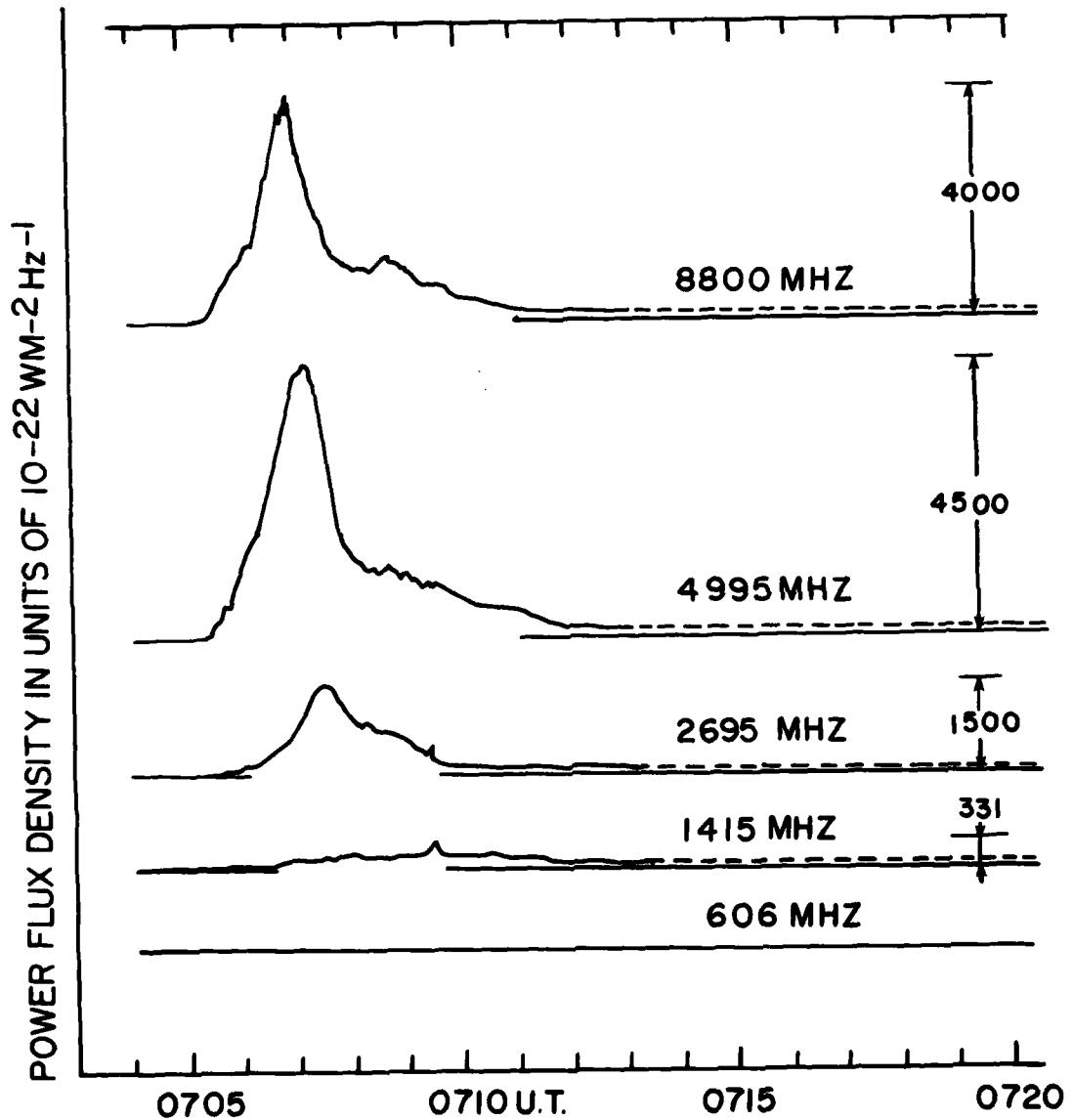


RADIO BURST OBSERVED
ON 26 DECEMBER 1969
AT MANILA OBSERVATORY

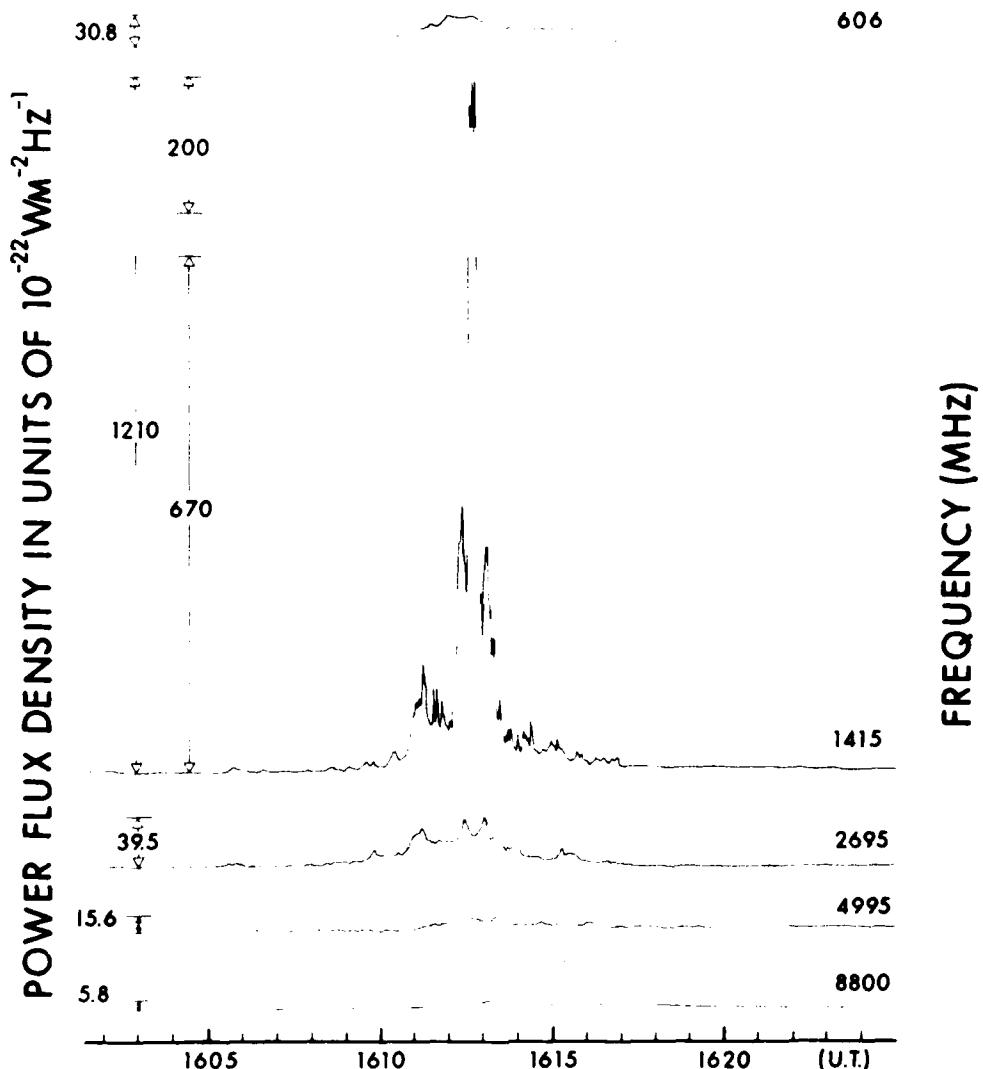
**Solar Radio Bursts
1970**



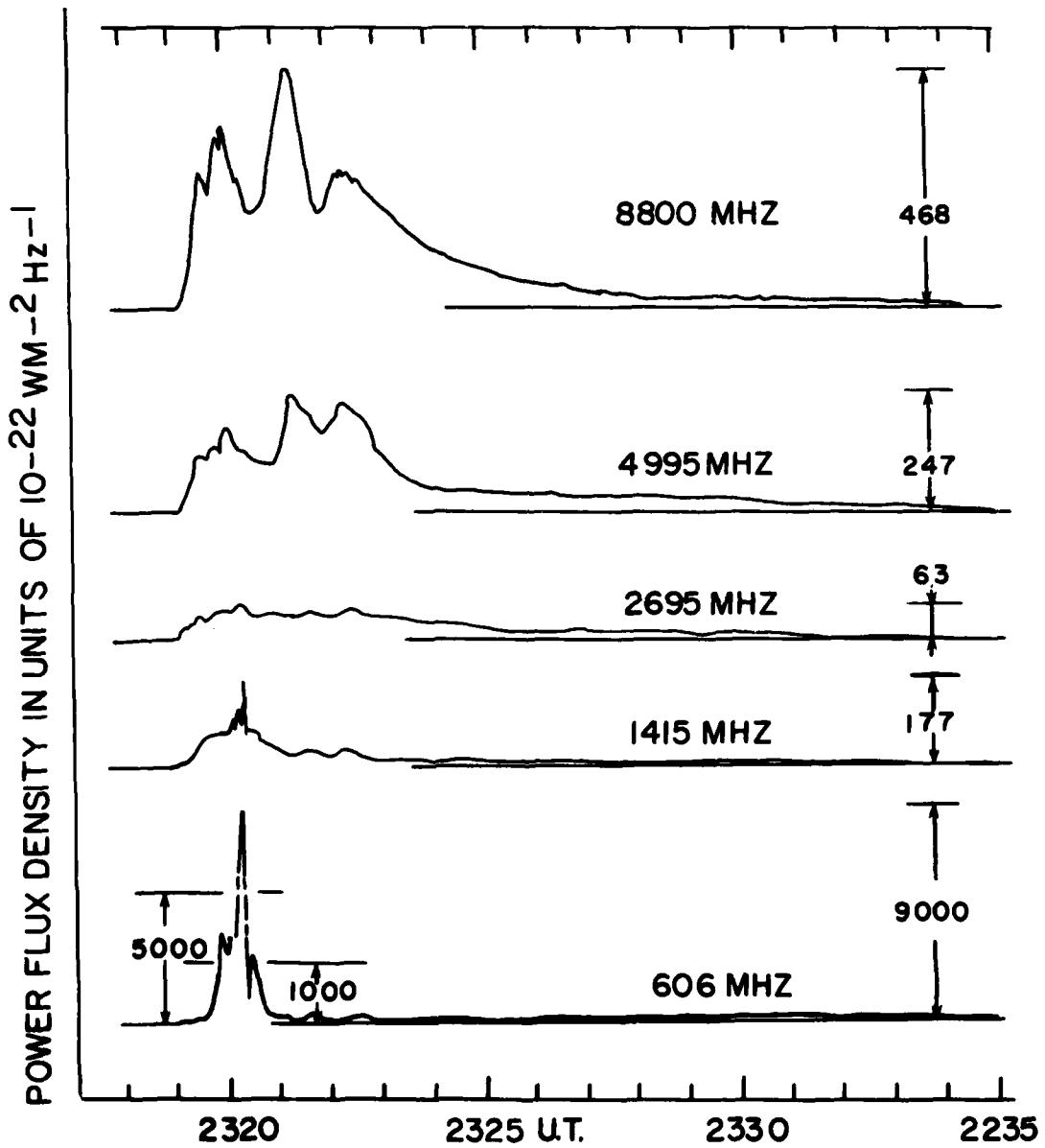
GREAT BURST OBSERVED ON 28 JANUARY, 1970
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



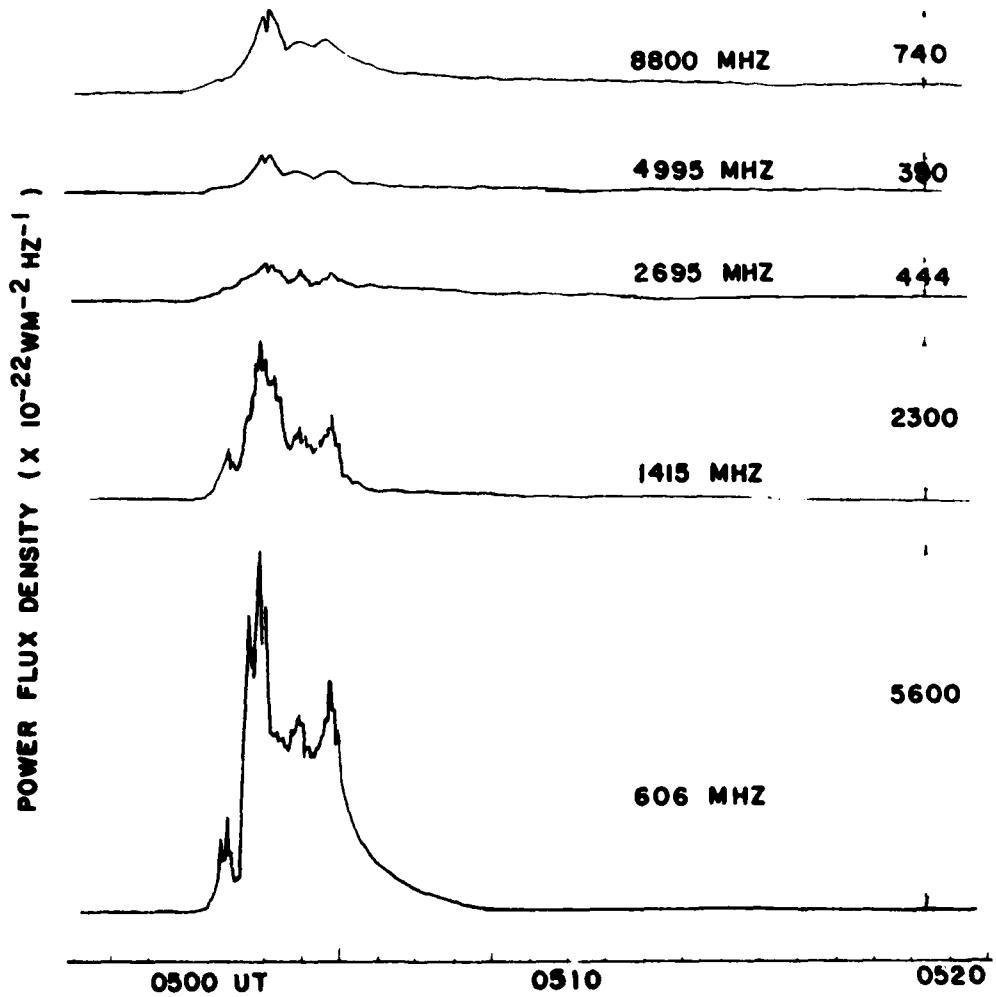
GREAT RADIO BURST OF 11 FEBRUARY, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.



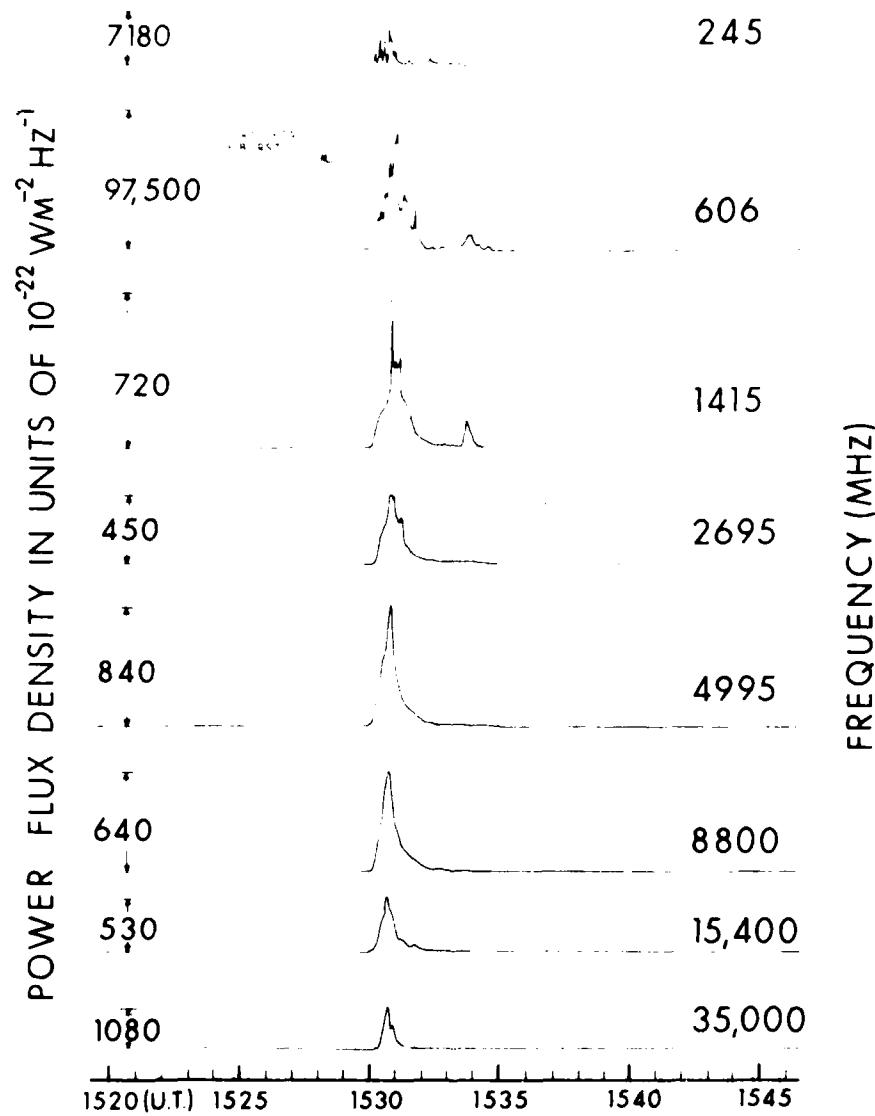
COMPLEX BURST OBSERVED 21 FEBRUARY, 1970
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



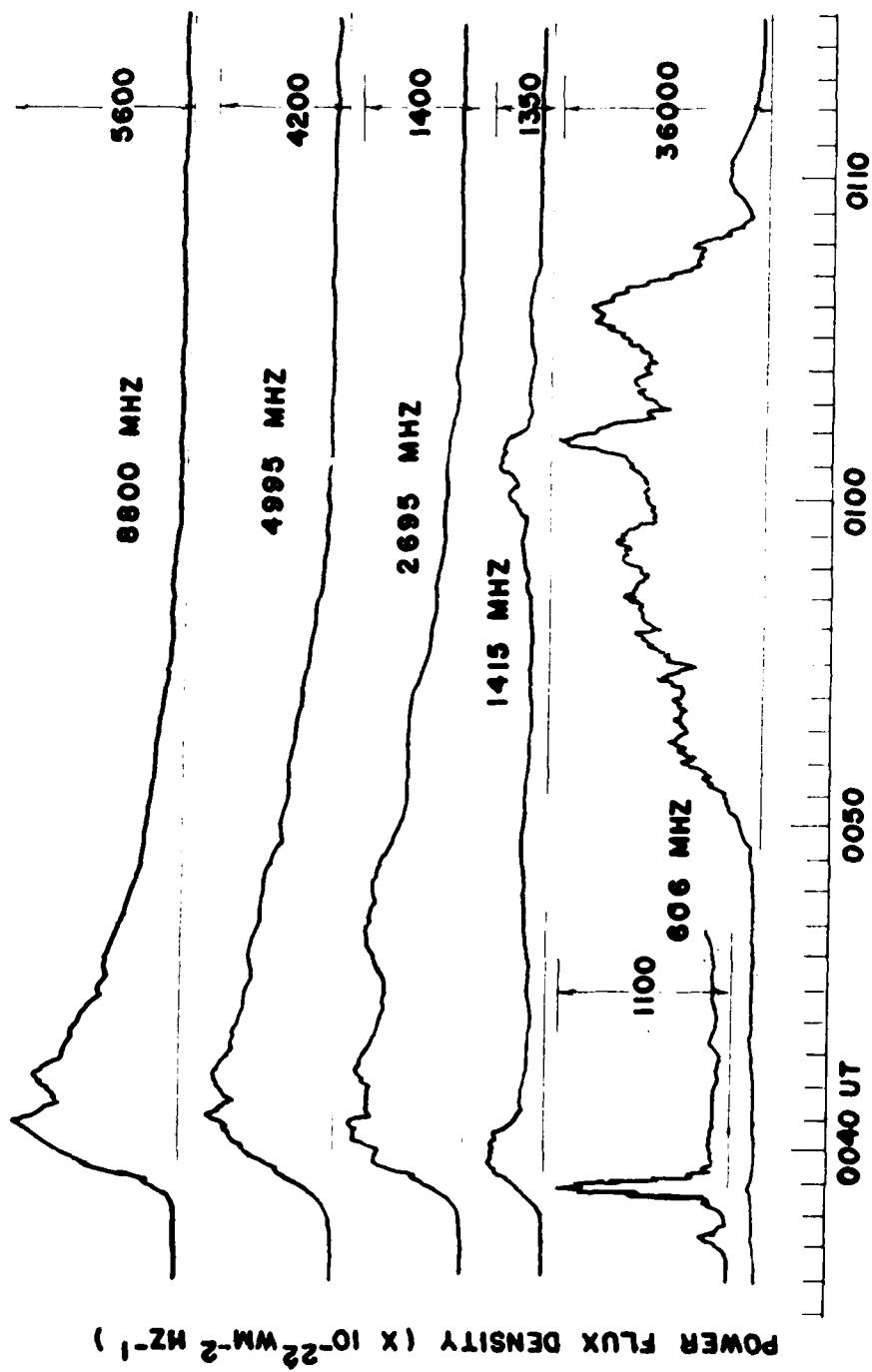
COMPLEX RADIO BURST OF 27 FEBRUARY, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.



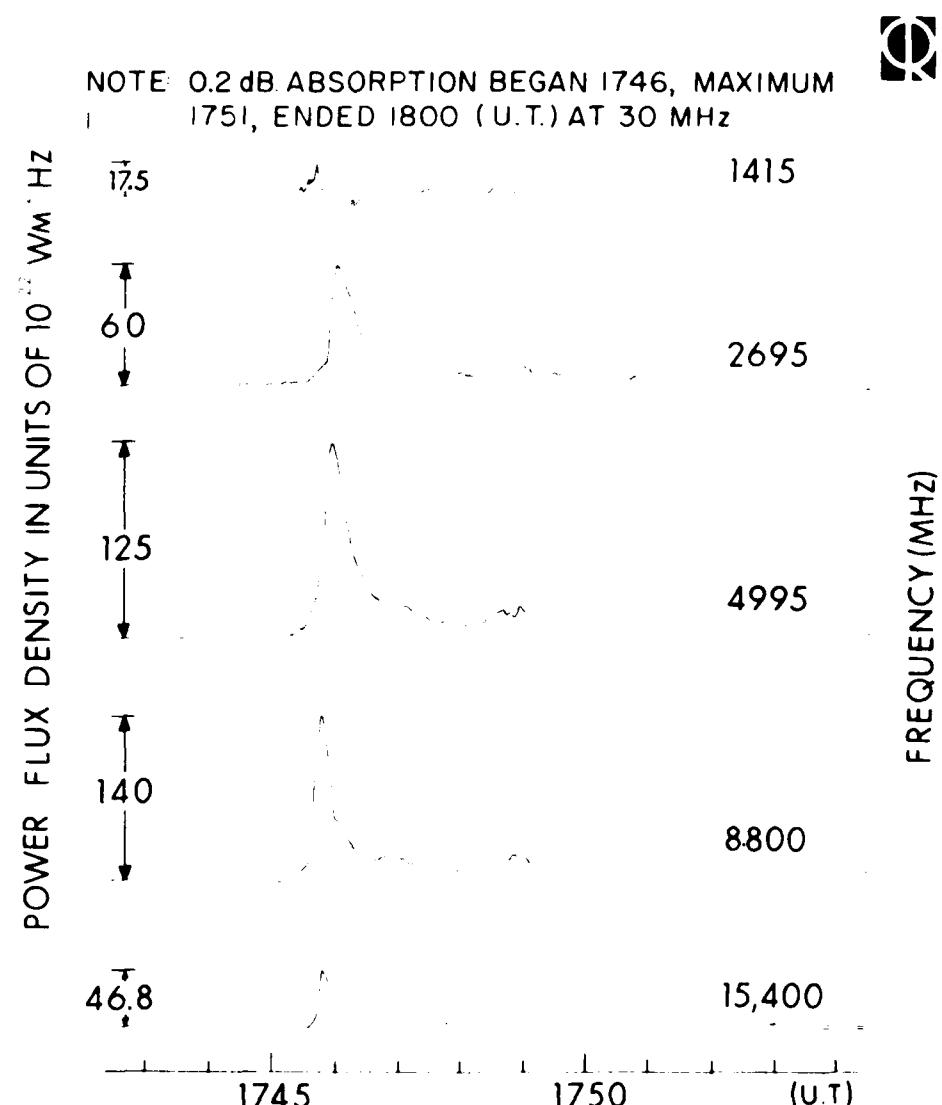
SIMPLE 2F RADIO BURST OF 1 MARCH, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.



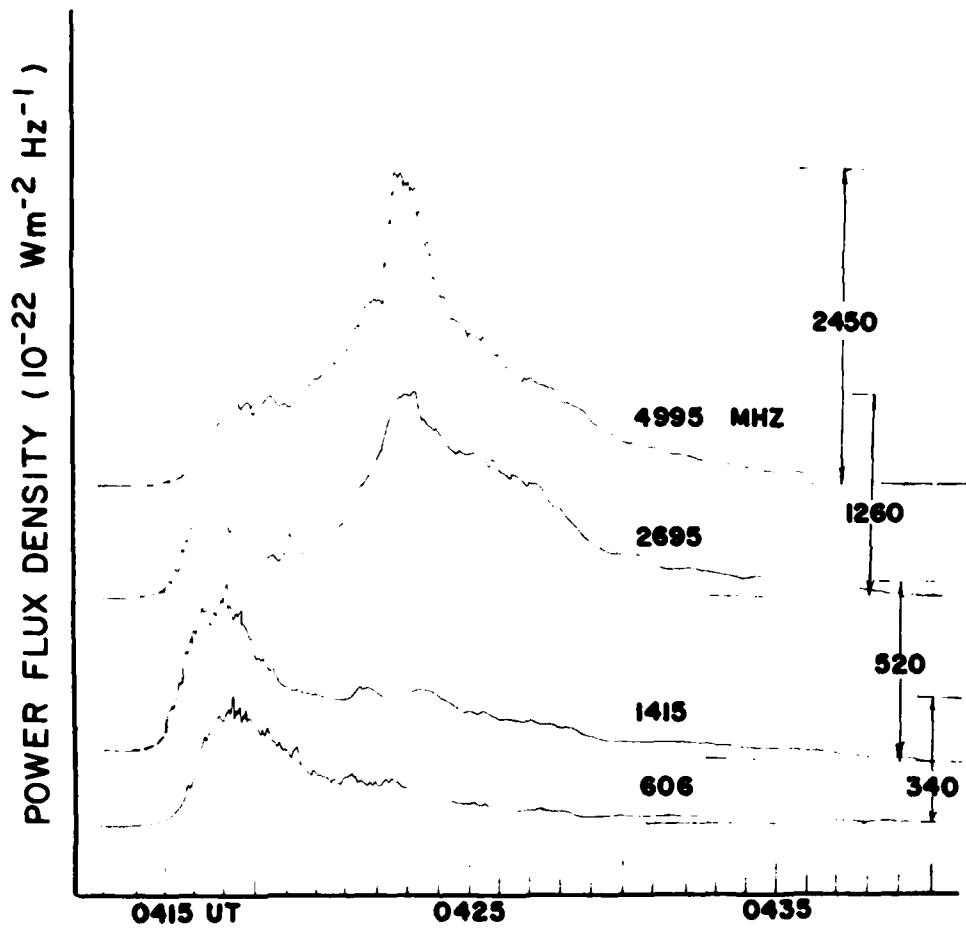
SIMPLE 2 AND COMPLEX RADIO BURST OBSERVED ON
1 MARCH, 1970 AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



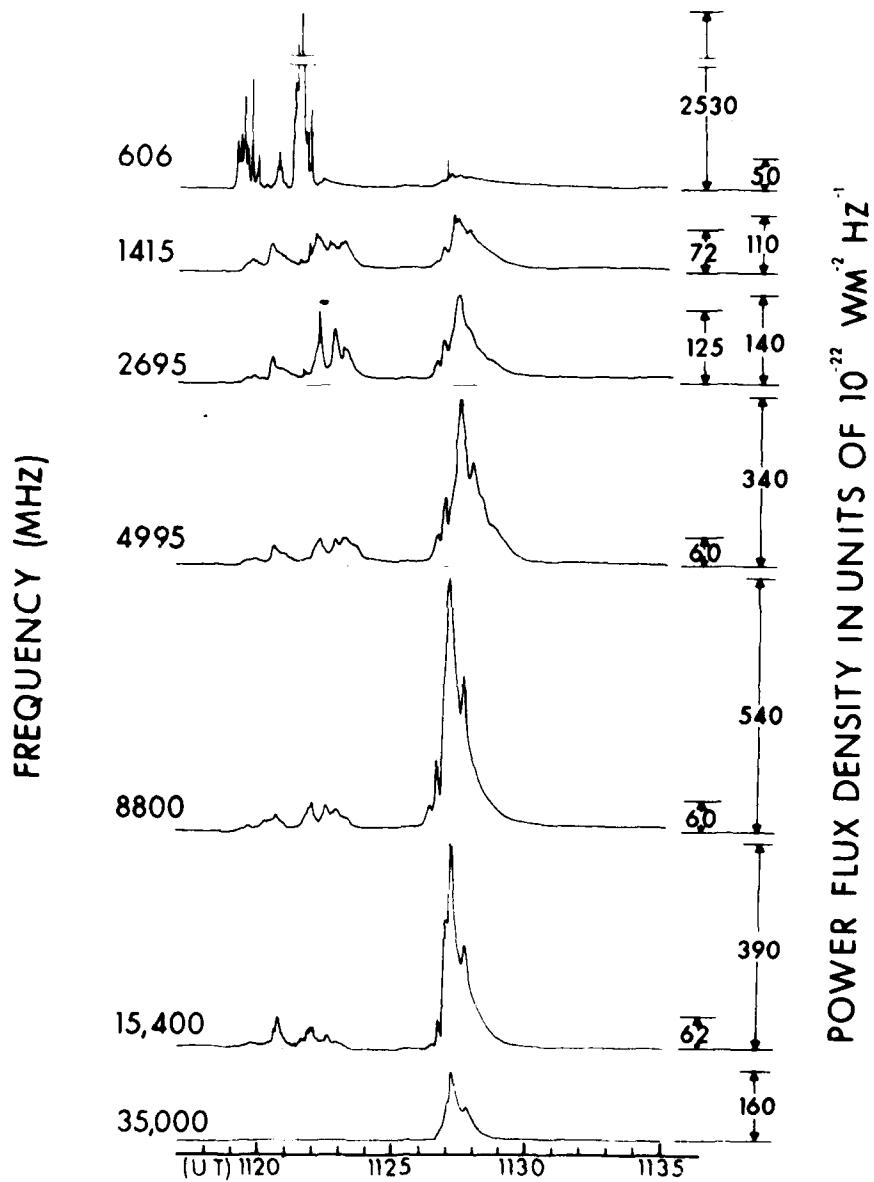
GREAT RADIO BURST OF 29 MARCH, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.



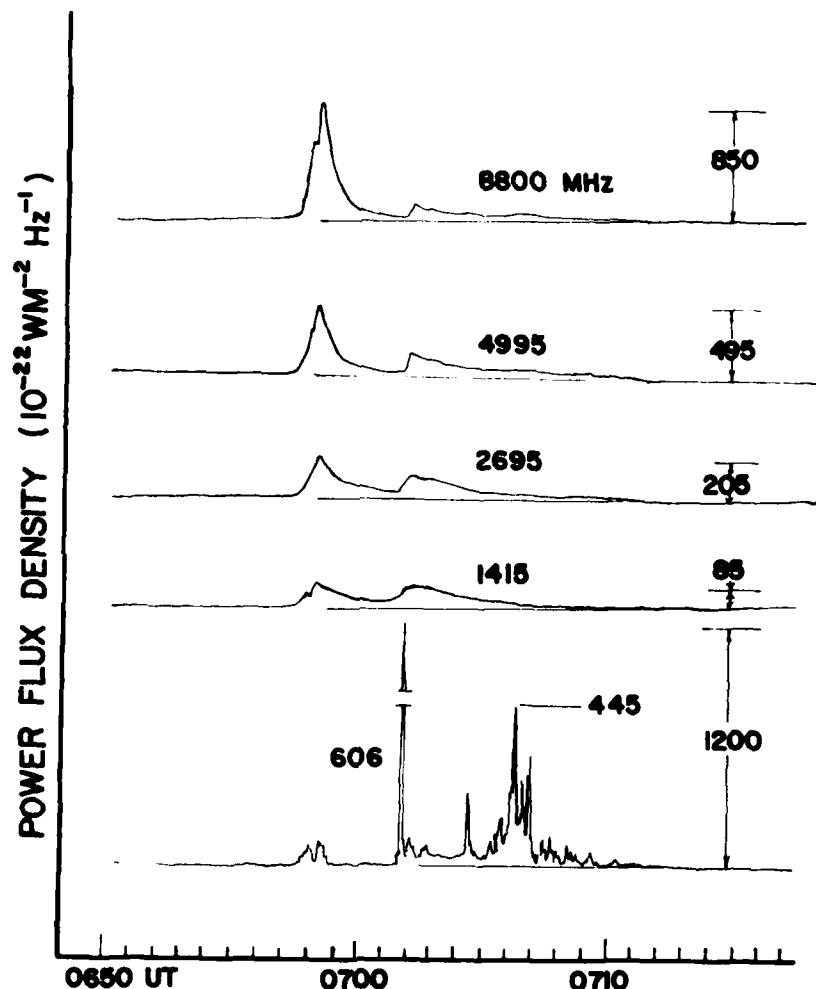
SIMPLE 2 RADIO BURST OBSERVED
ON 5 APRIL, 1970 AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



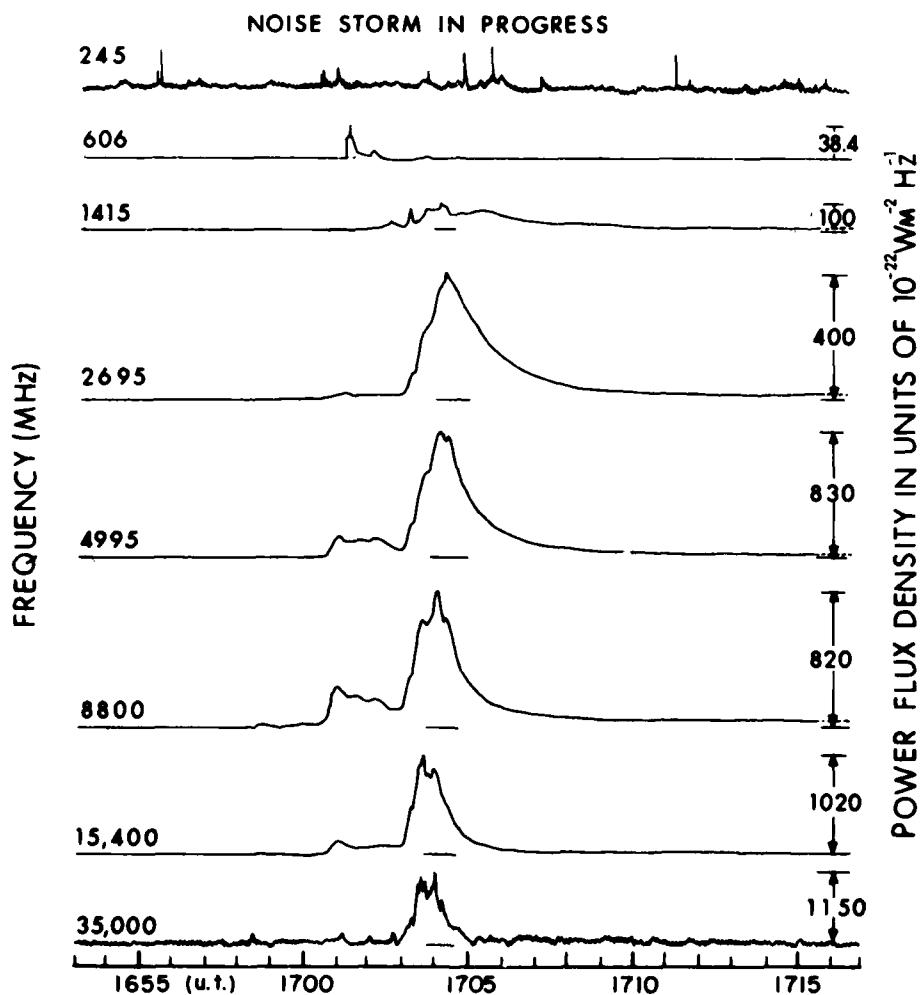
GREAT RADIO BURST OF APRIL 15, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.
OUTAGE ON X-BAND



COMPLEX & SIMPLE 2F RADIO BURST OBSERVED 29 MAY, 1970
AT SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

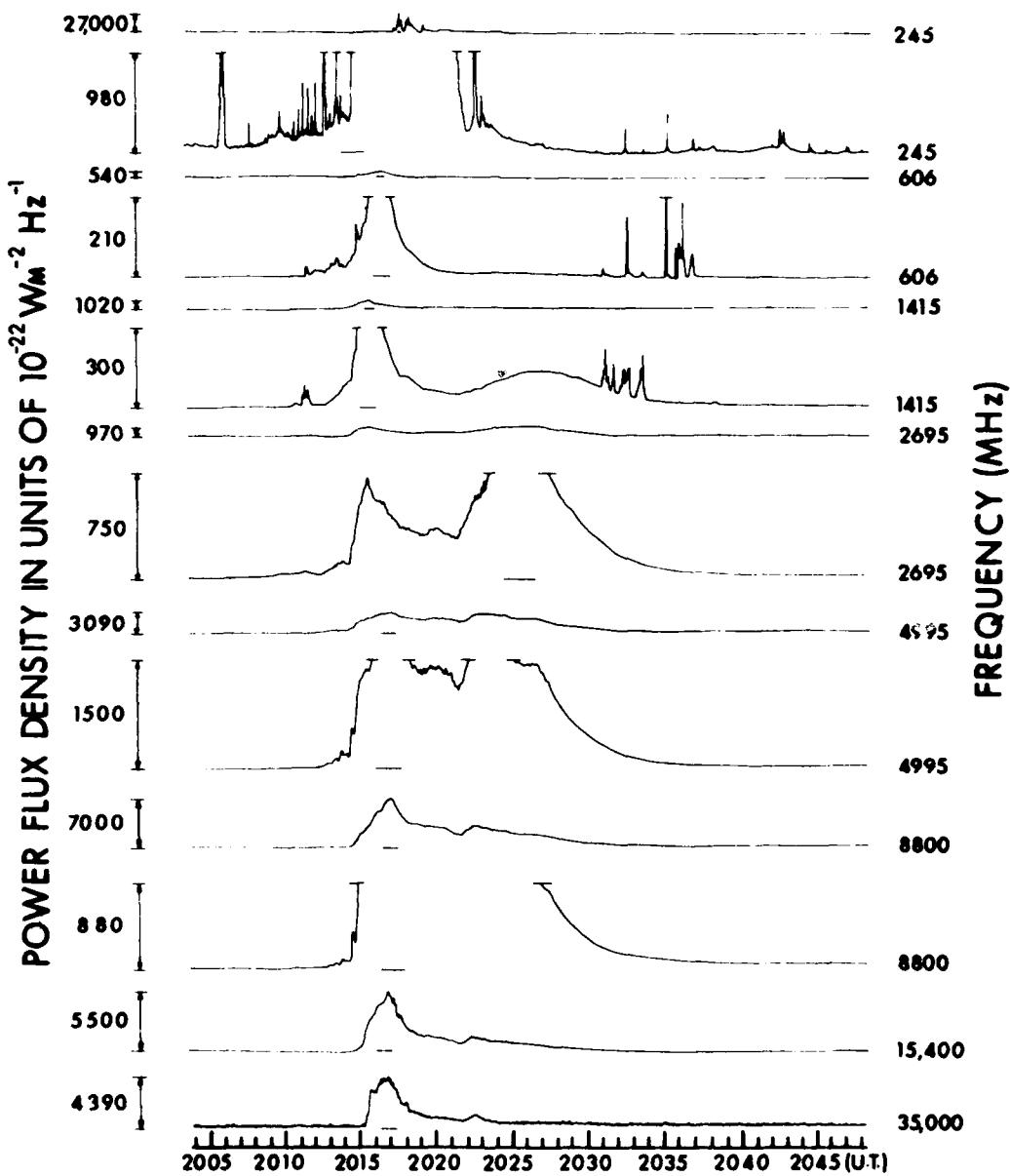


COMPLEX RADIO BURST OBSERVED ON
JUNE 13, 1970 AT MANILA OBSERVATORY,
R. P.

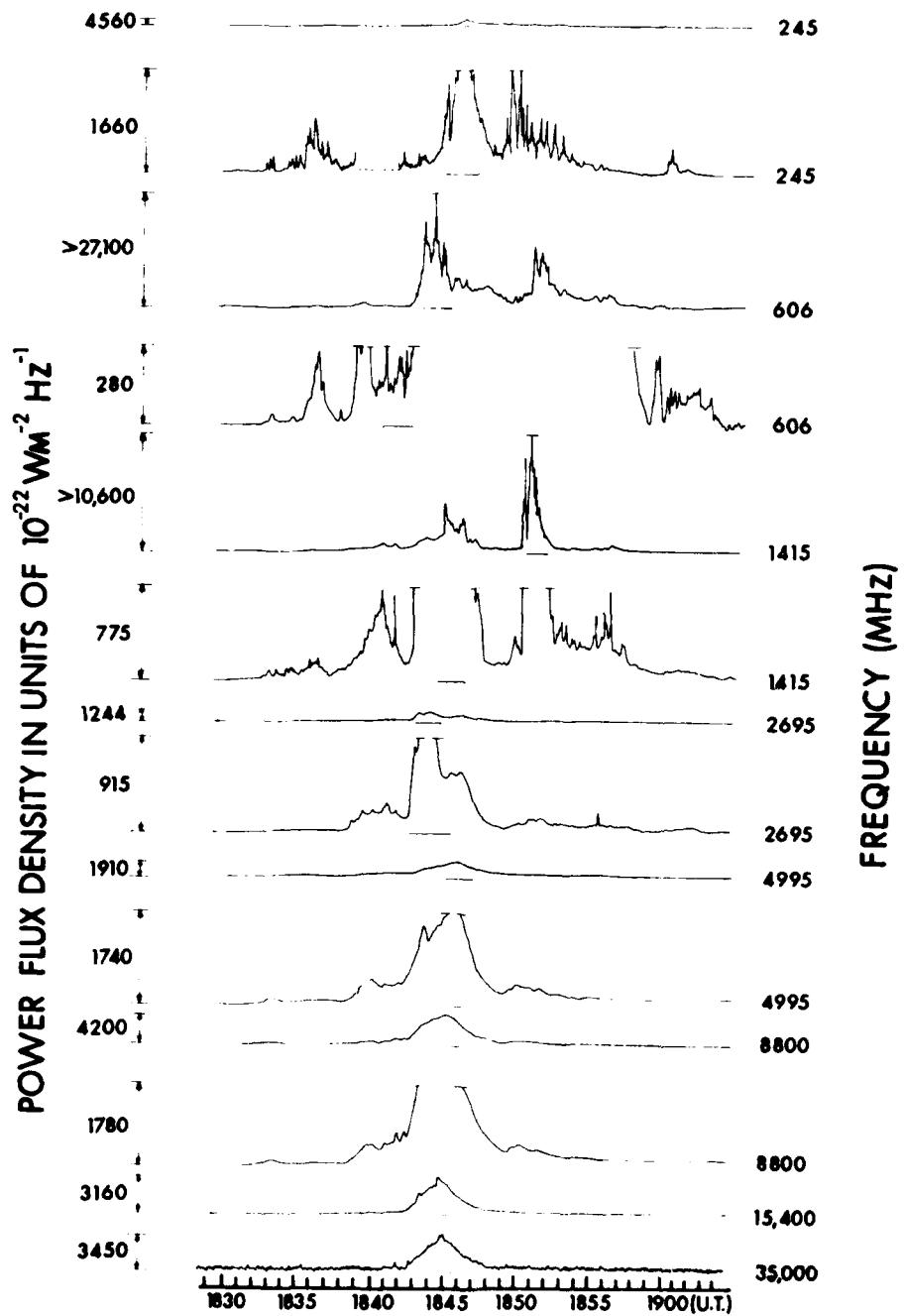


COMPLEX AND 2F RADIO BURST OBSERVED ON 14 JUNE, 1970
 AT SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

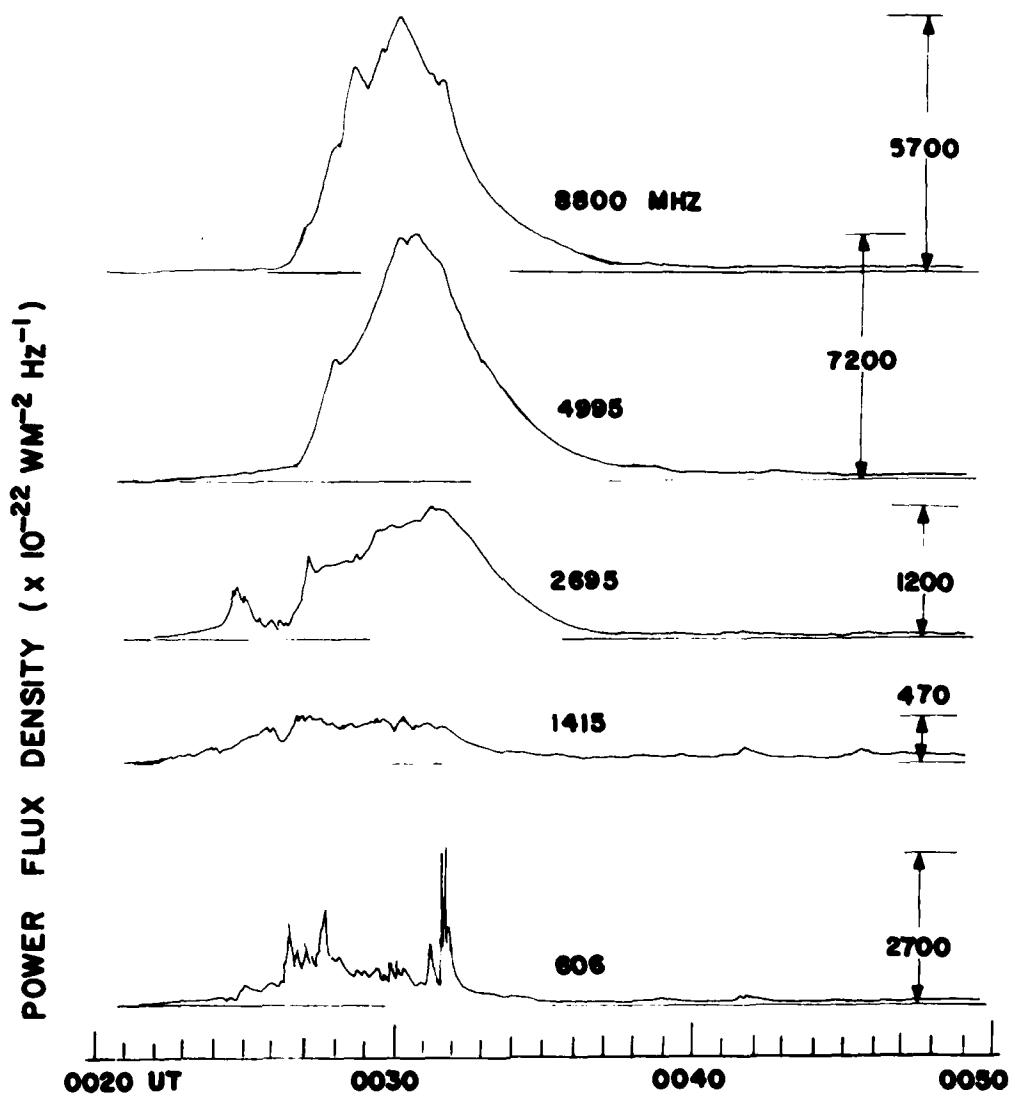
Note: 4.5 db absorption observed at 1706 u.t. on 30 MHz riometer.



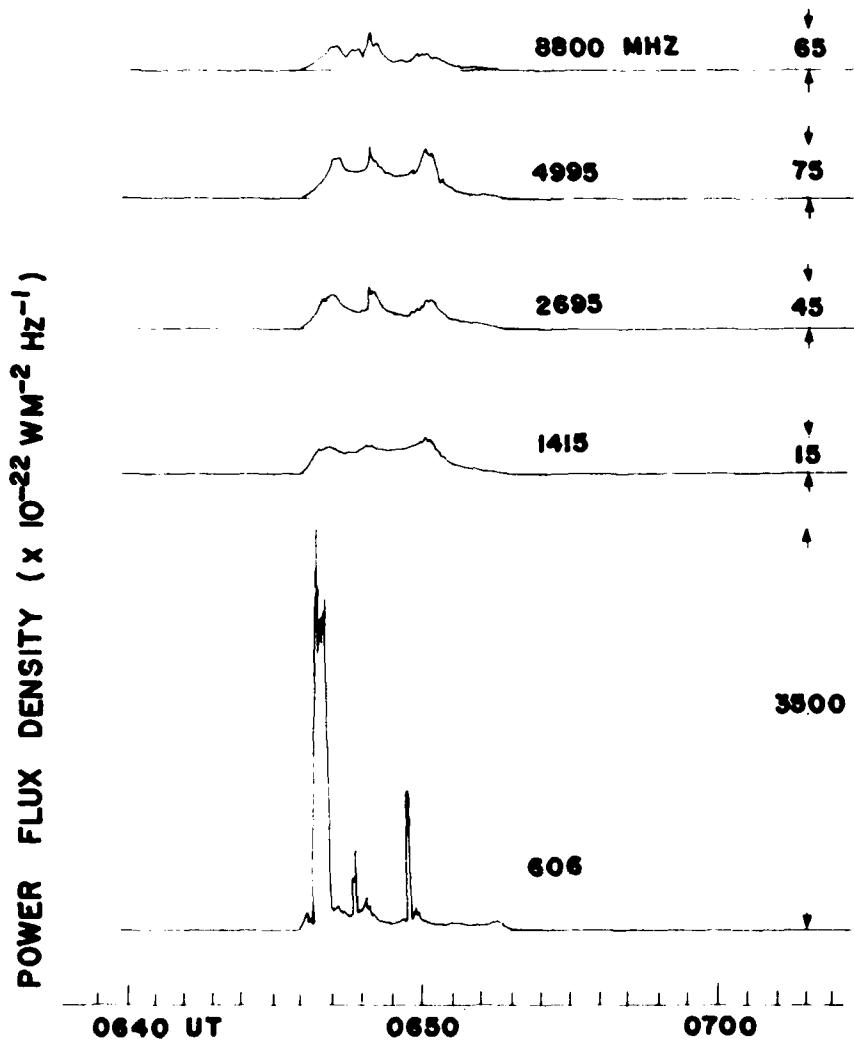
**GREAT BURST OBSERVED 12 AUGUST, 1970 AT SAGAMORE HILL
RADIO OBSERVATORY, HAMILTON, MASS.**



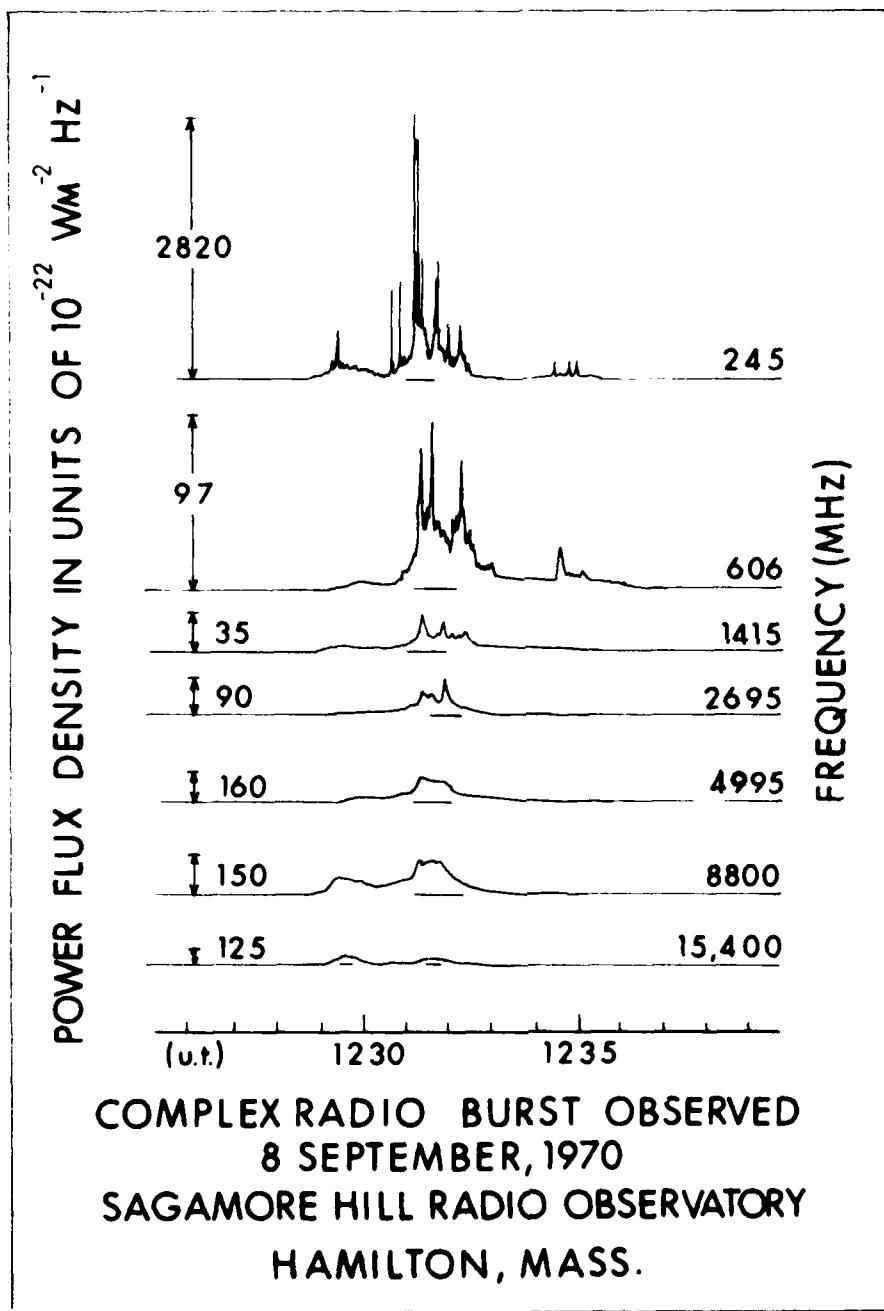
GREAT BURST OBSERVED 23 JULY, 1970 AT SAGAMORE HILL
RADIO OBSERVATORY, HAMILTON, MASS.

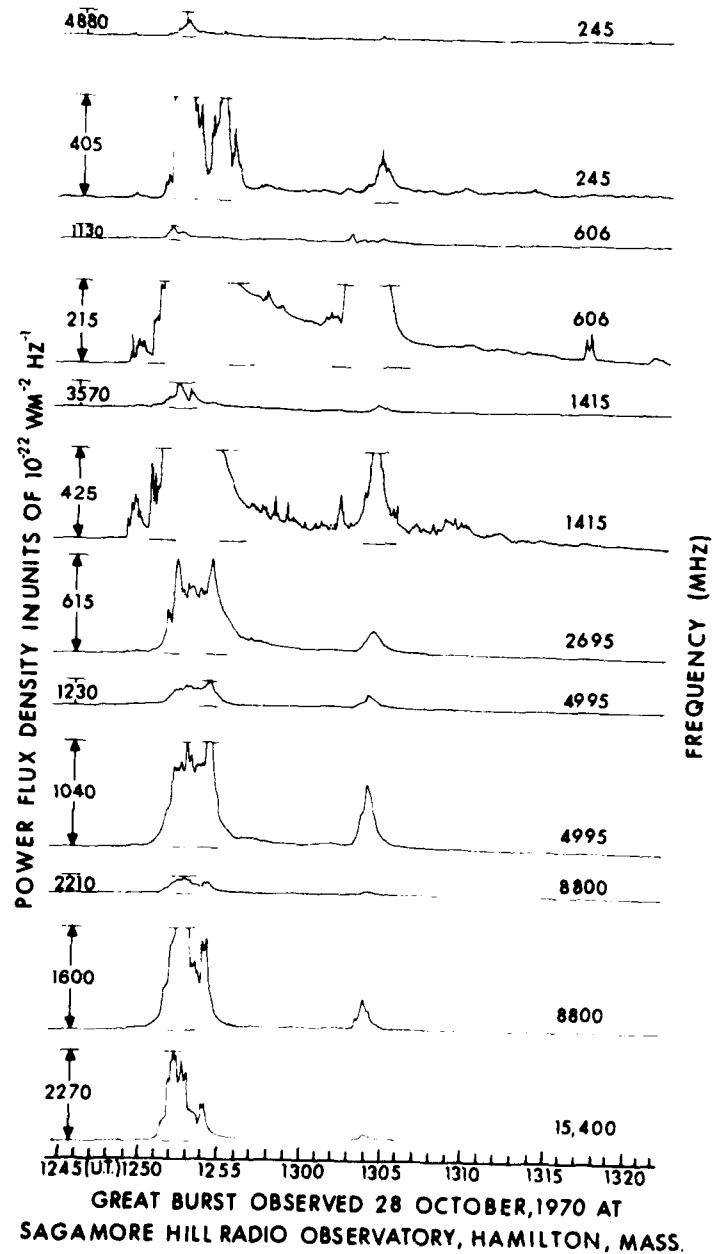


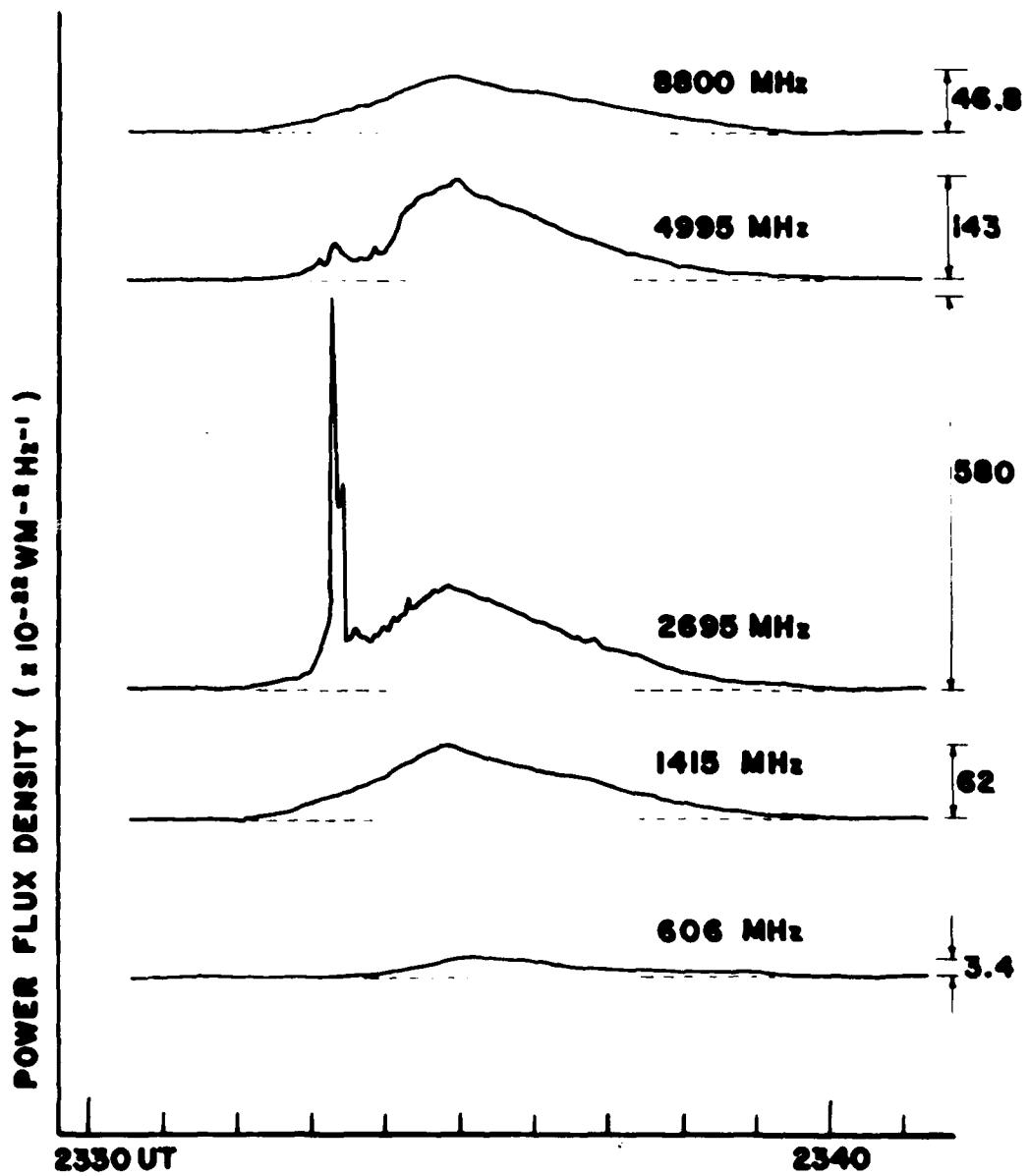
**GREAT RADIO BURST OF JULY 22, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.**



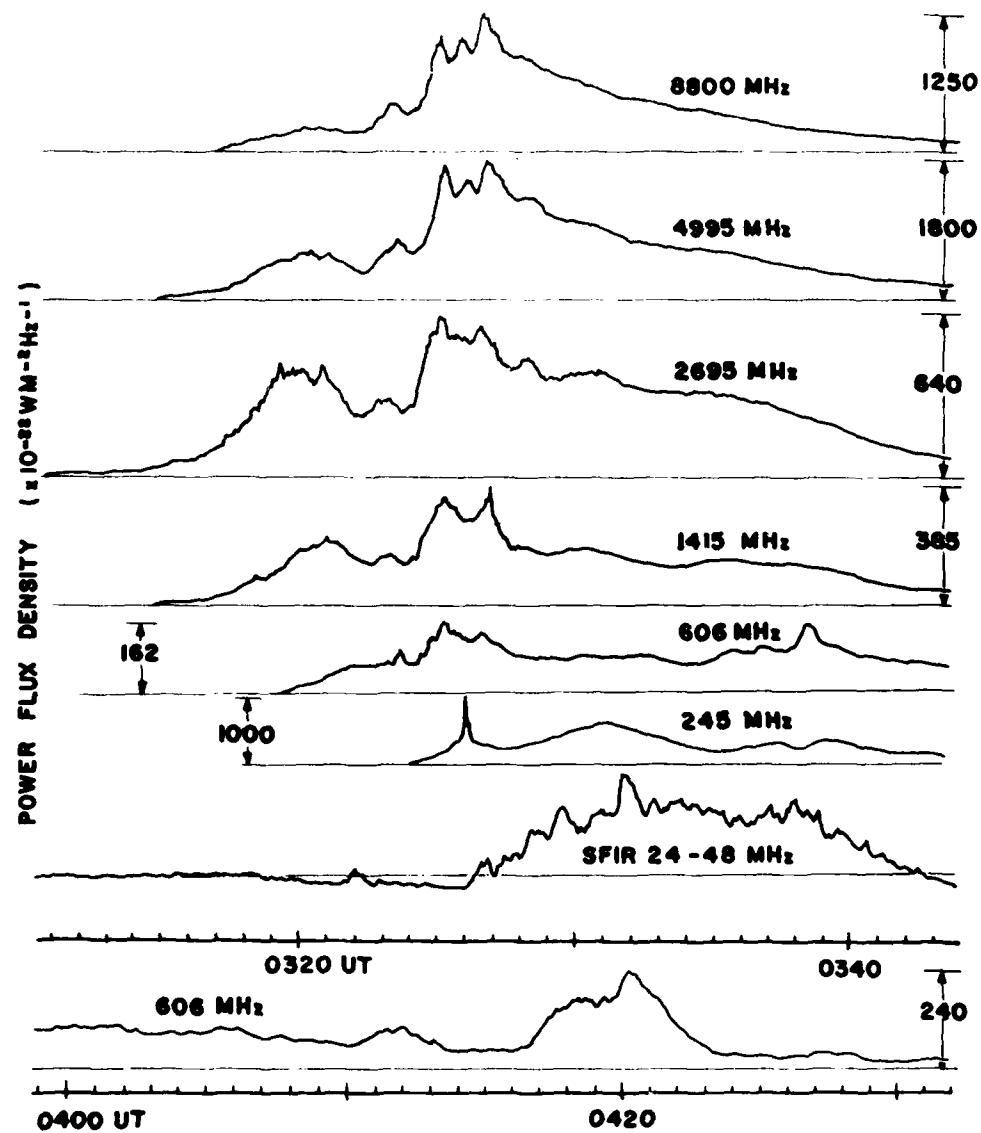
COMPLEX F RADIO BURST OF AUGUST 29, 1970
OBSERVED AT MANILA OBSERVATORY, R.P.



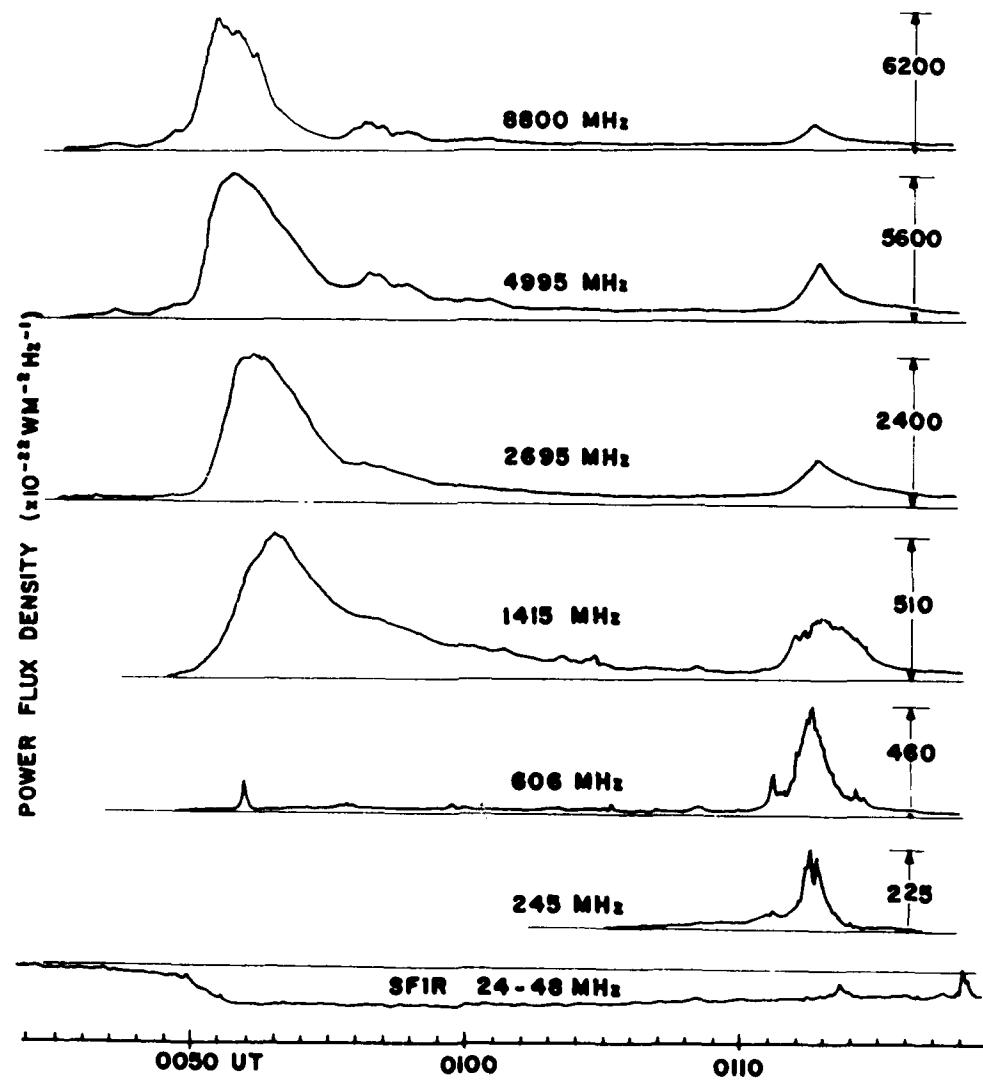




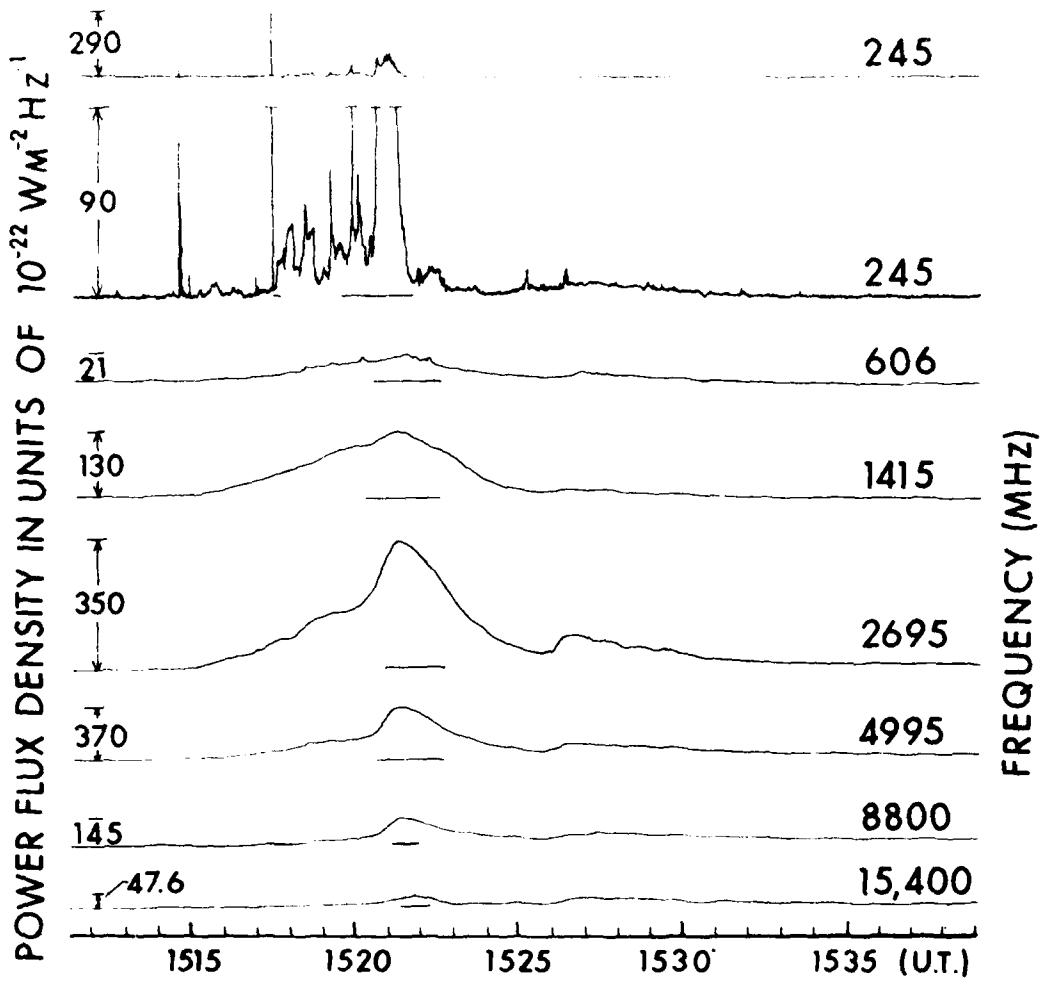
**SIMPLE 2 & COMPLEX F BURSTS OBSERVED ON
30 OCTOBER 1970 AT MANILA OBSERVATORY, R.P.**



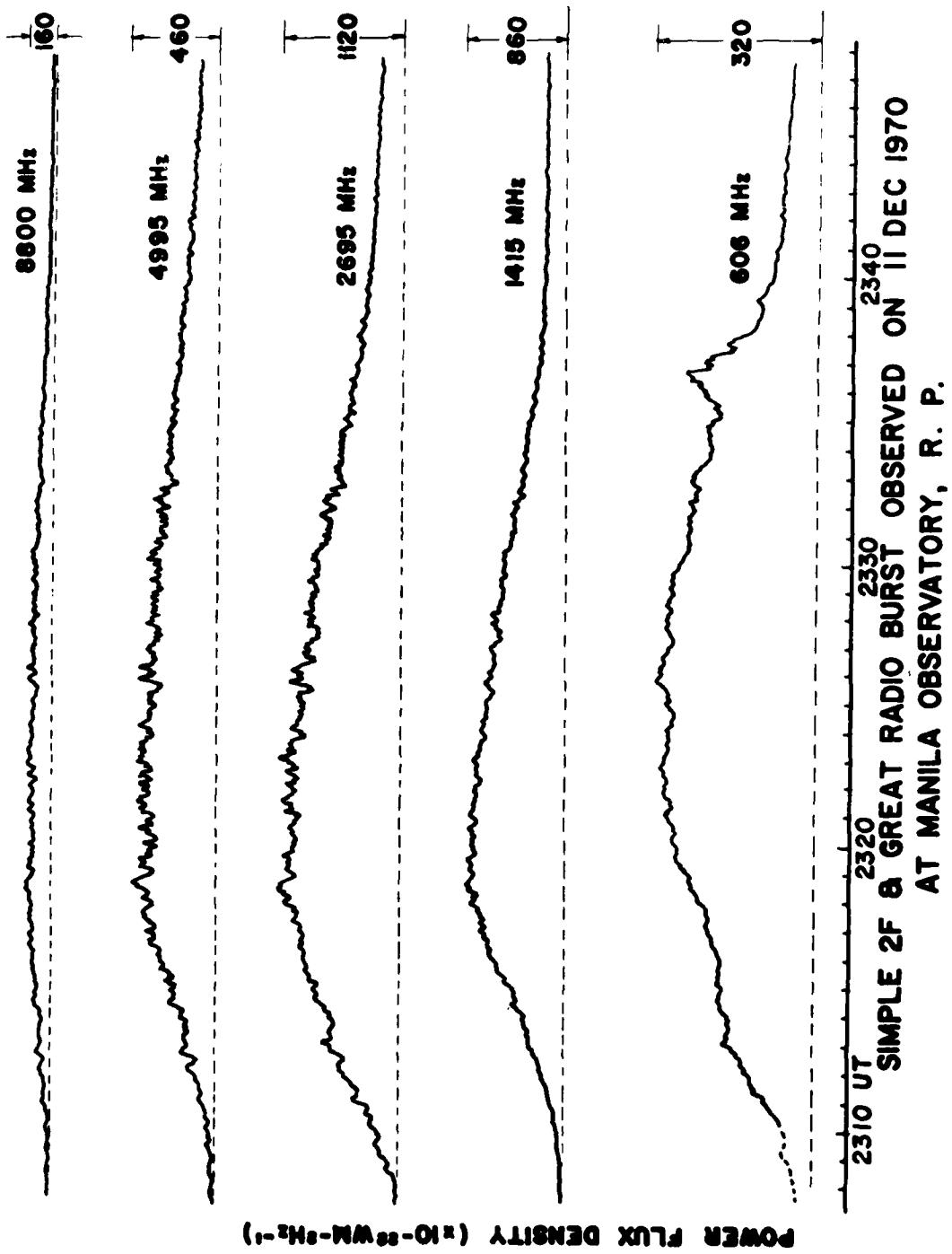
COMPLEX F RADIO BURST OBSERVED AT MANILA
OBSERVATORY, R.P., ON 5 NOVEMBER 1970

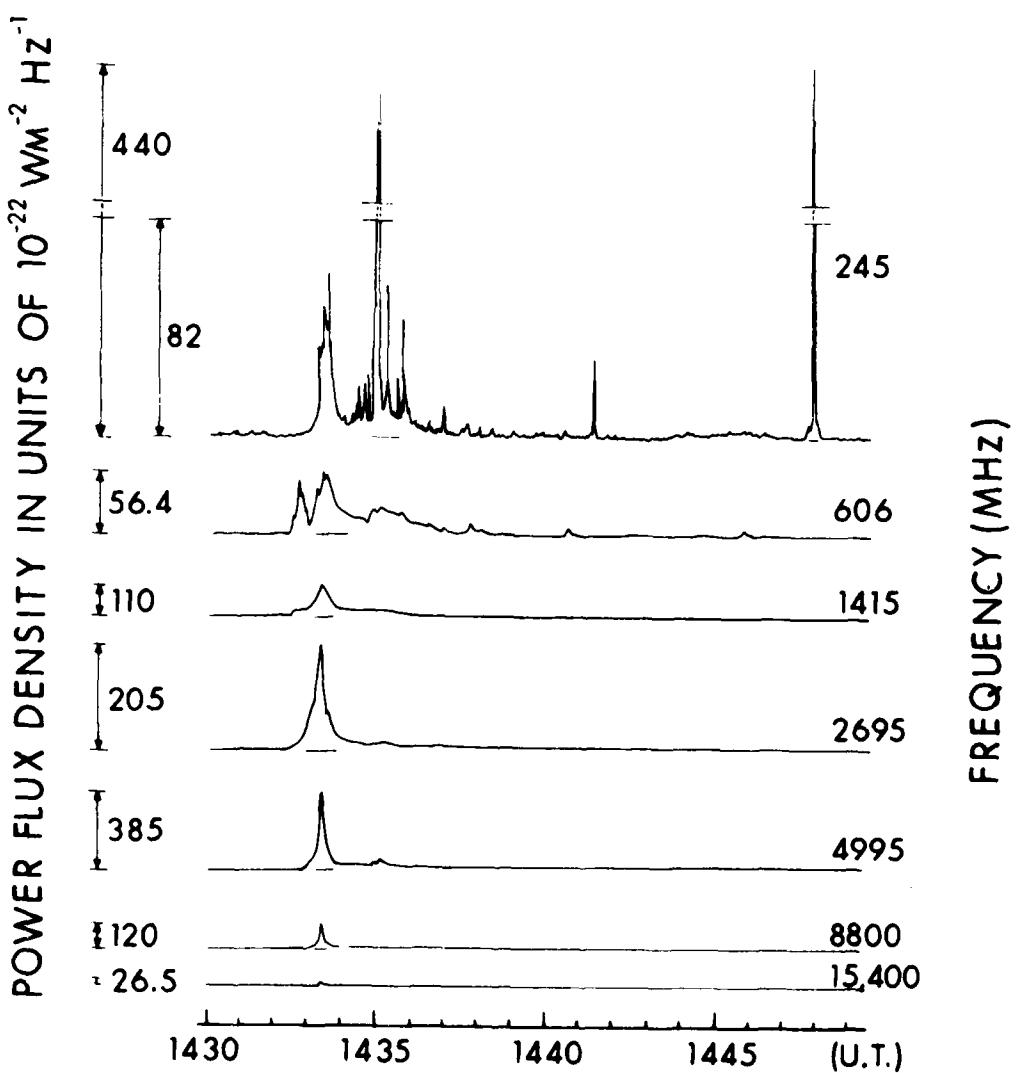


**GREAT RADIO BURST OBSERVED ON 16 NOVEMBER 1970
AT MANILA OBSERVATORY, R.P.**



SIMPLE 2 AND COMPLEX RADIO BURST OBSERVED
21 NOVEMBER, 1970-SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

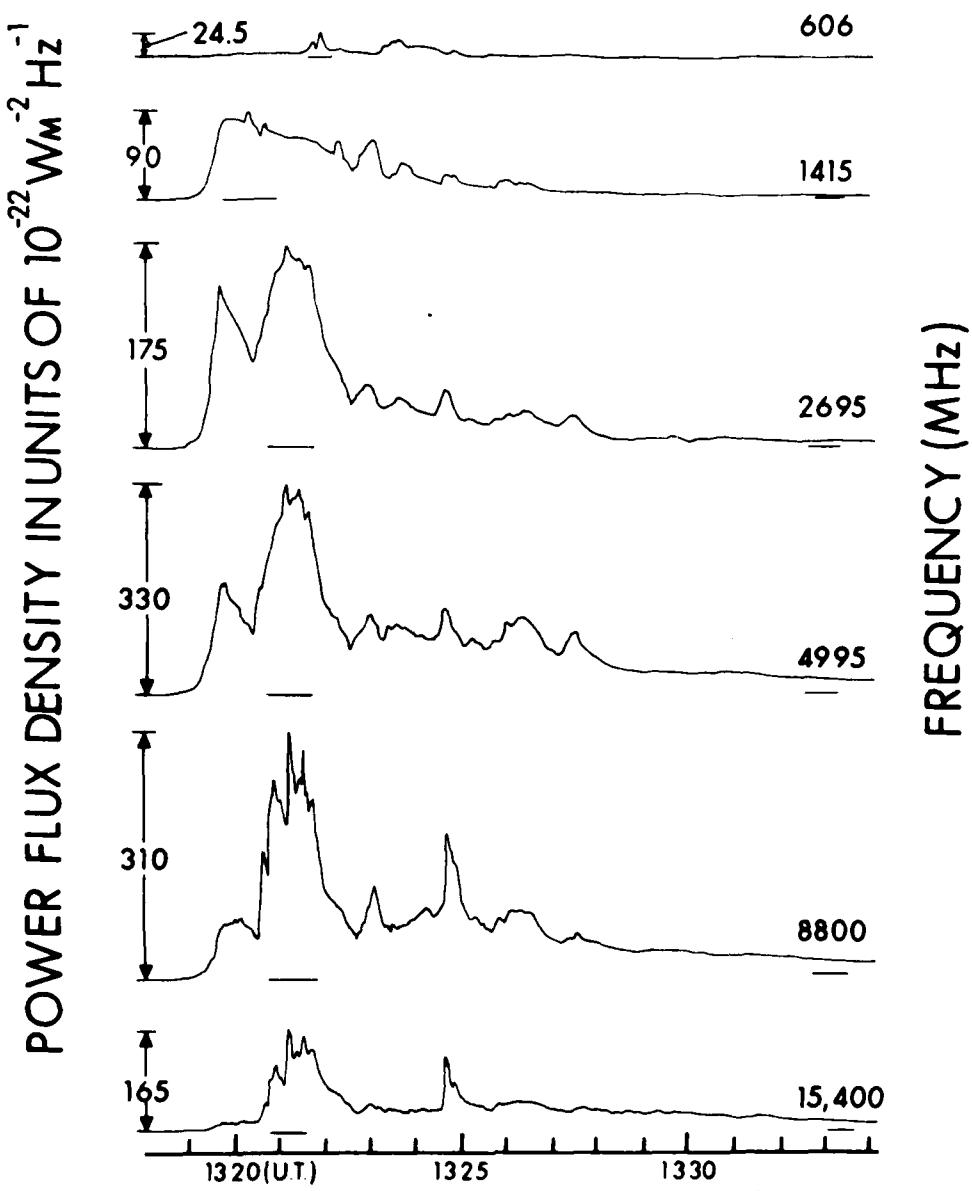




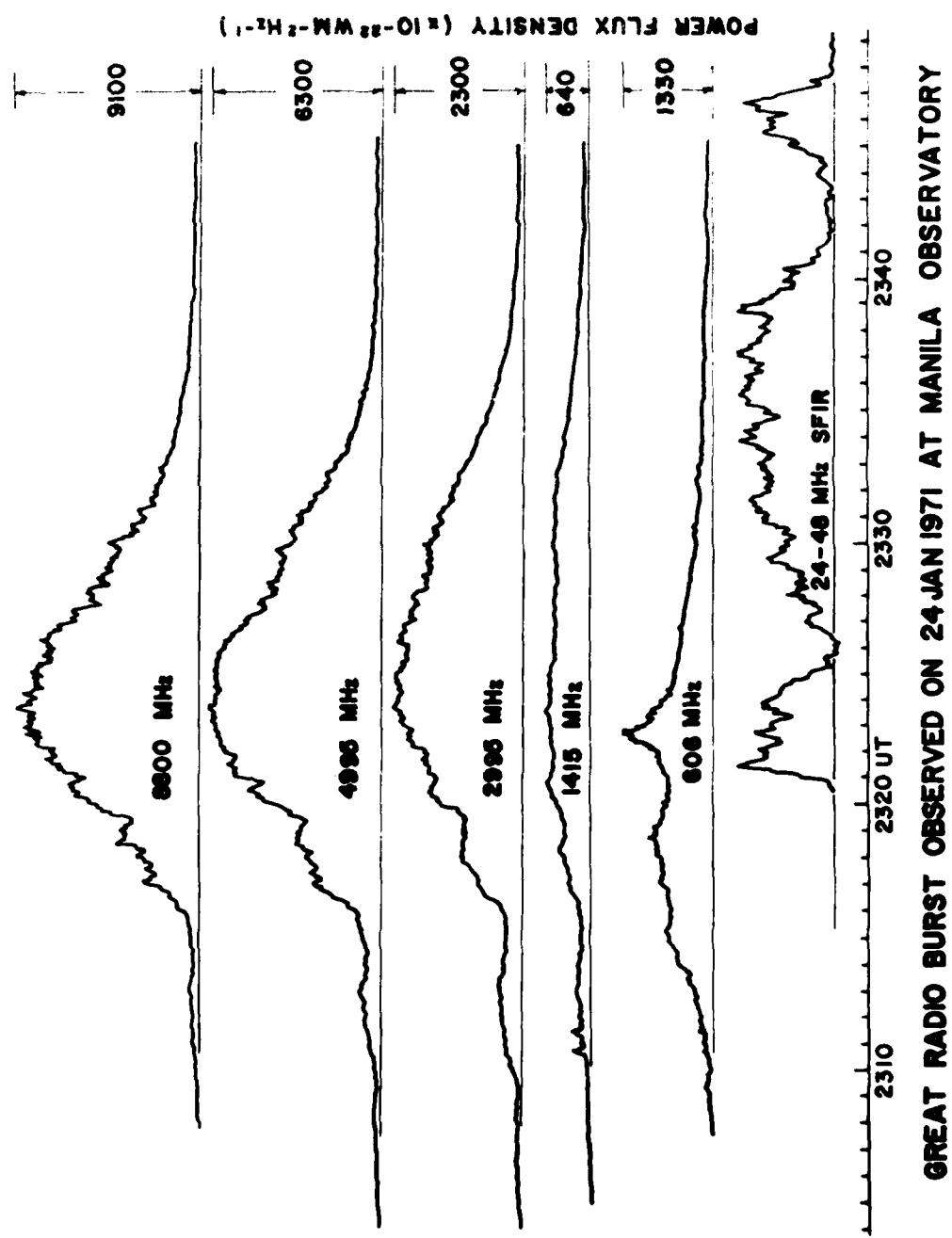
SIMPLE 2 AND COMPLEX RADIO BURST OBSERVED

12 DECEMBER, 1970
 AT SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

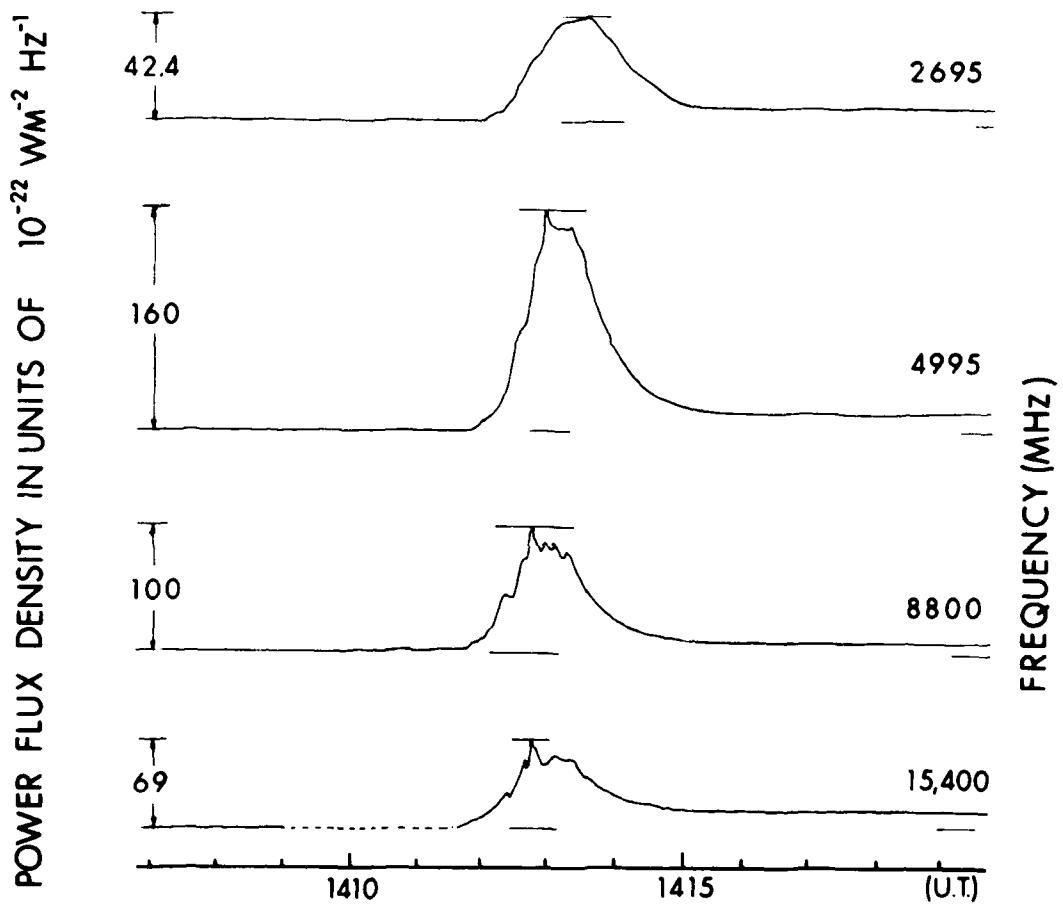
**Solar Radio Bursts
1971**



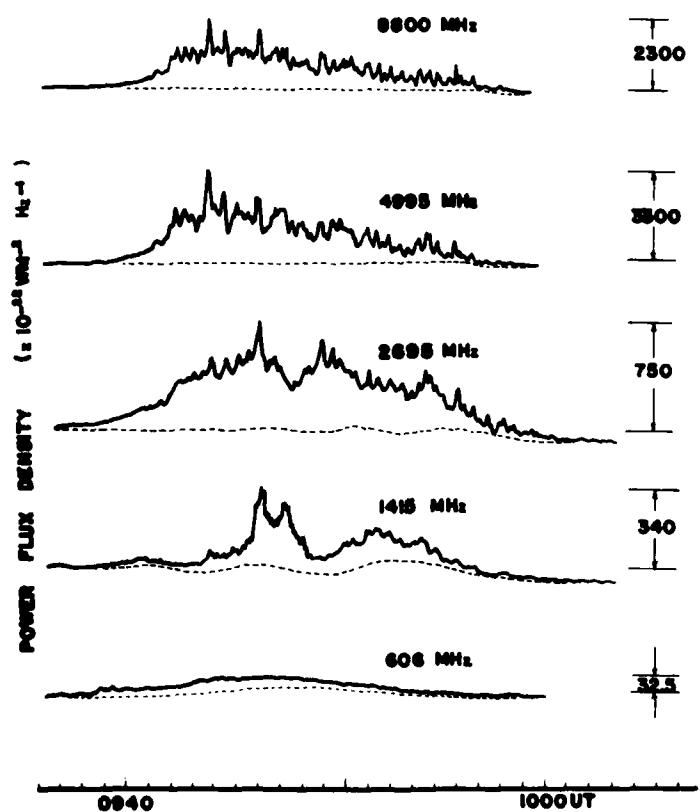
COMPLEX F RADIO BURST OBSERVED ON
21 JANUARY, 1971
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



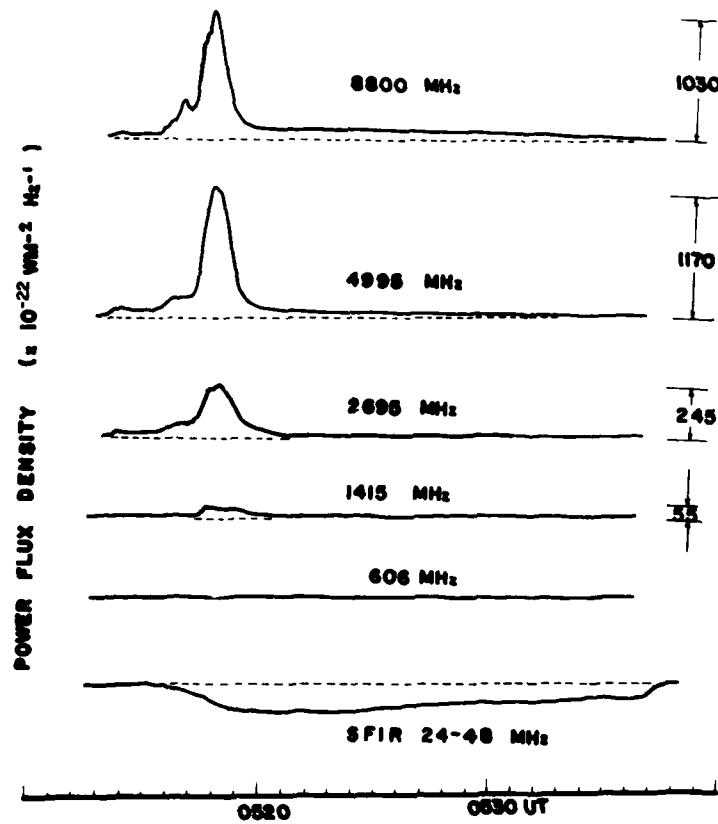
GREAT RADIO BURST OBSERVED ON 24 JAN 1971 AT MANILA OBSERVATORY



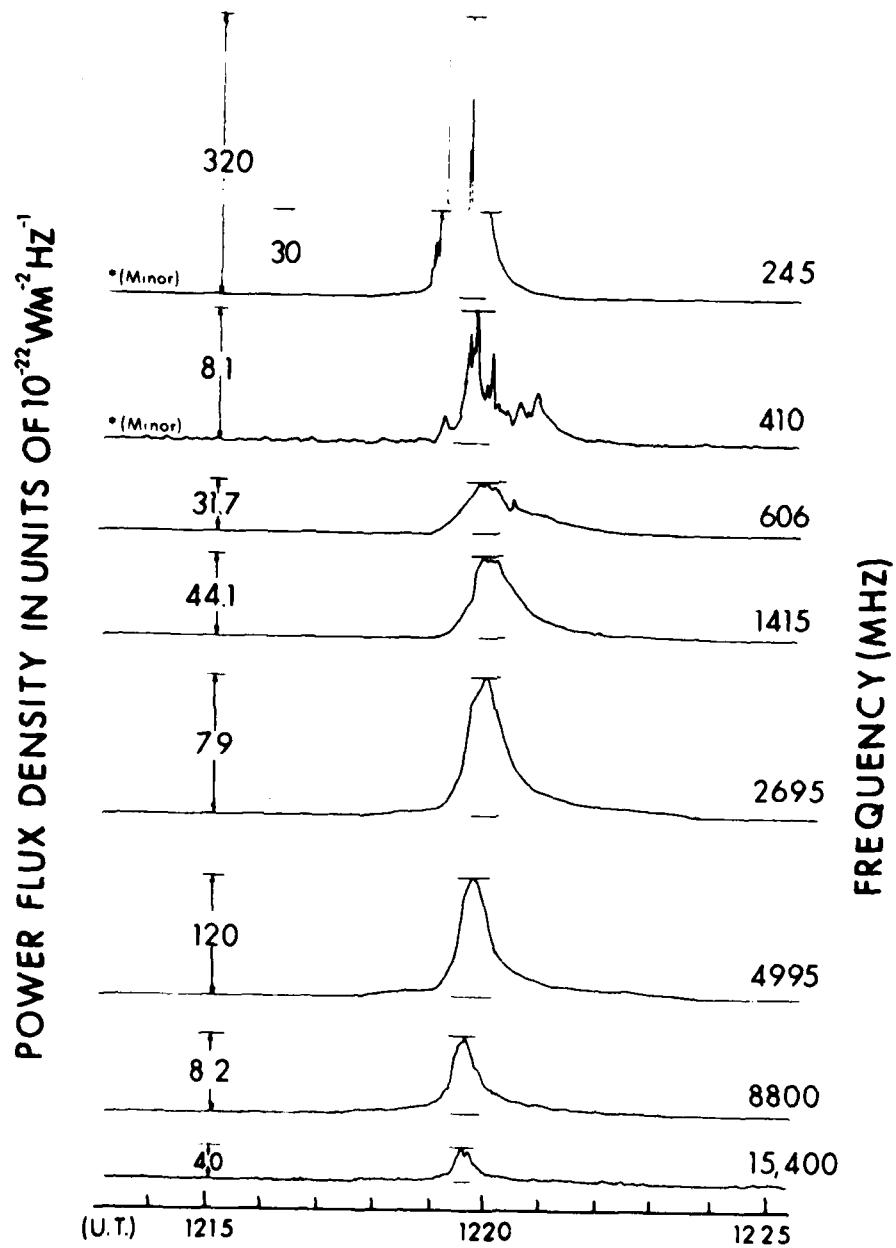
SIMPLE 2 AND 2F RADIO BURST OBSERVED ON
 29 MARCH, 1971
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.



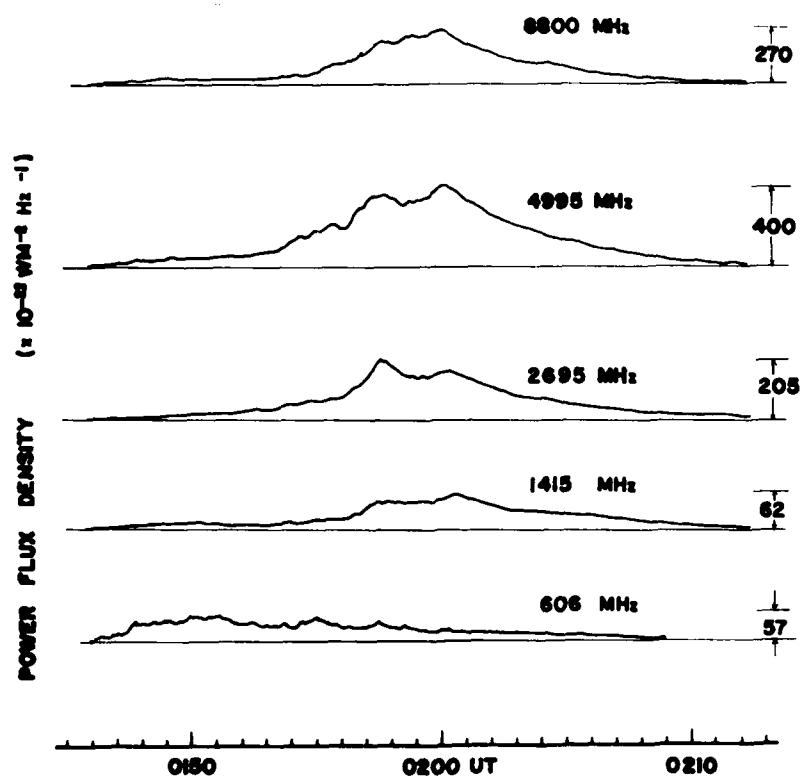
GREAT RADIO BURST OBSERVED AT SUNSET OF 8 APRIL
1971 AT MANILA OBSERVATORY, R.P.
DASHED LINES ARE TYPICAL QUIET SUN TRACES



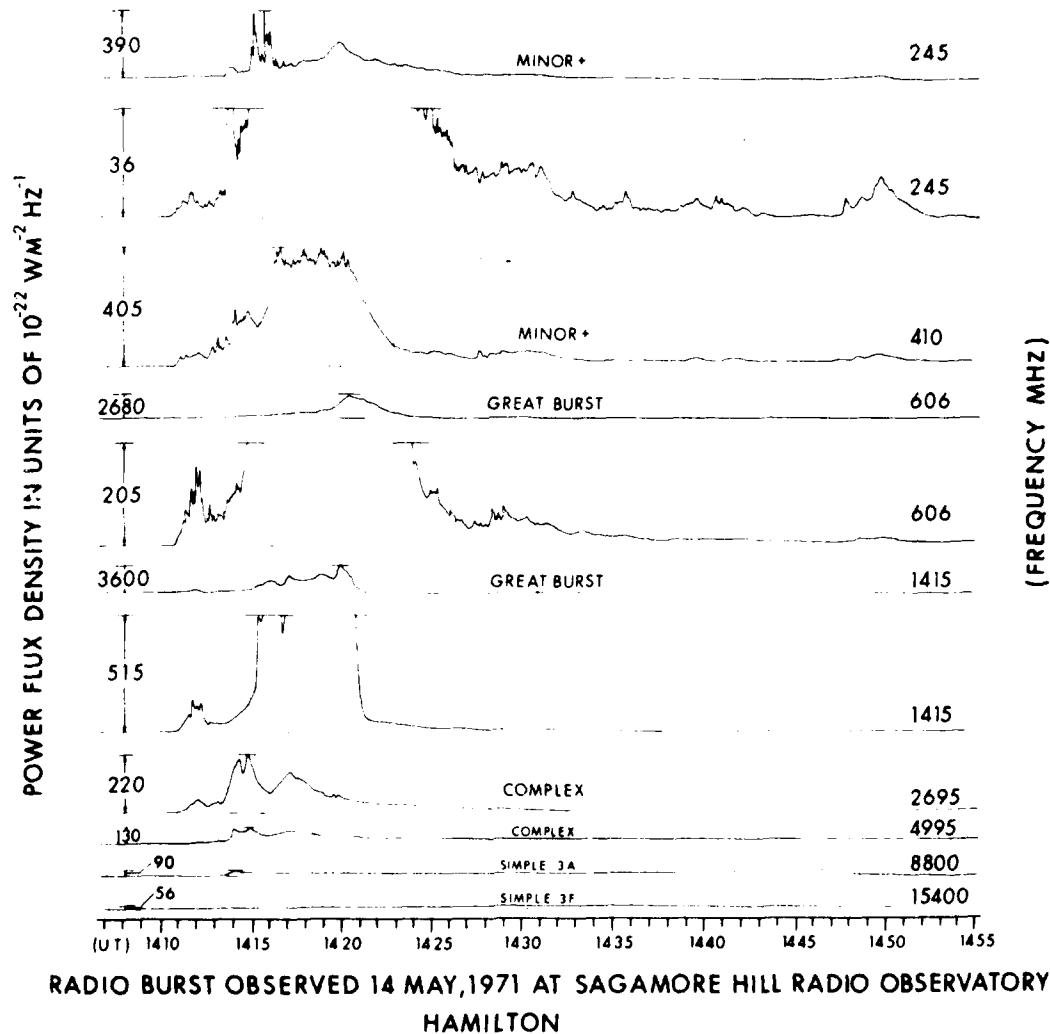
SIMPLE 2 & GREAT RADIO BURST OBSERVED ON
20 APRIL 1971 AT MANILA OBSERVATORY, R.P.

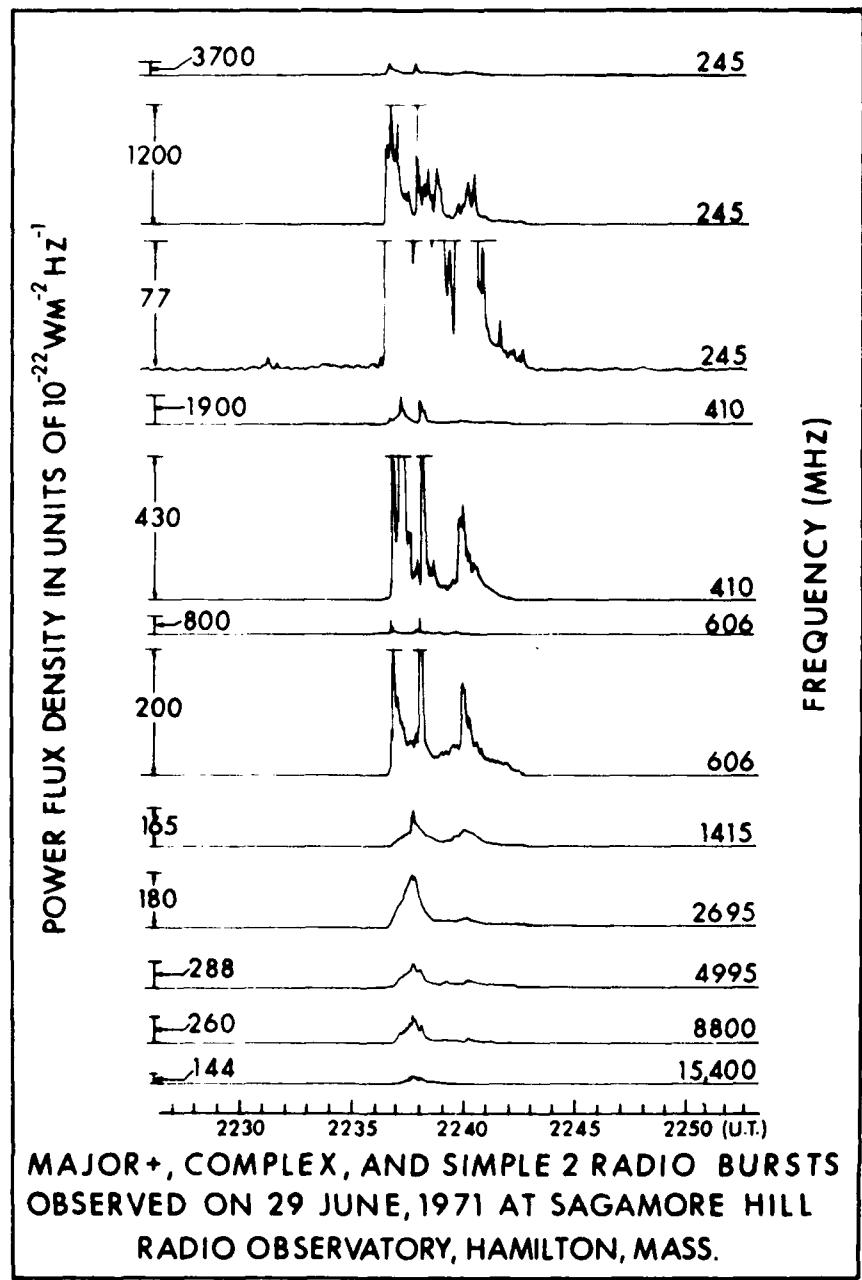


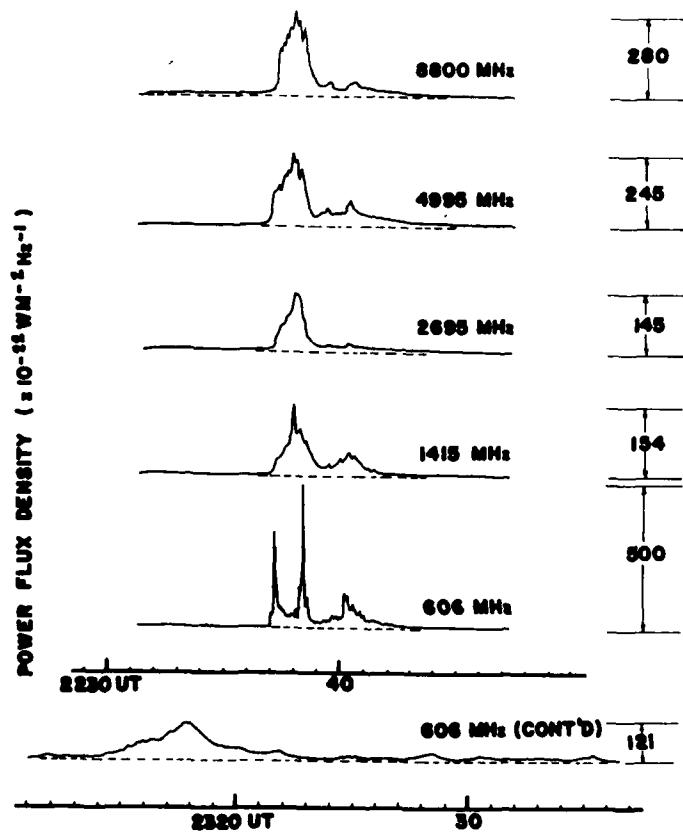
**SIMPLE 2 & 2F* RADIO BURST OBSERVED 20 APRIL, 1971
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.**



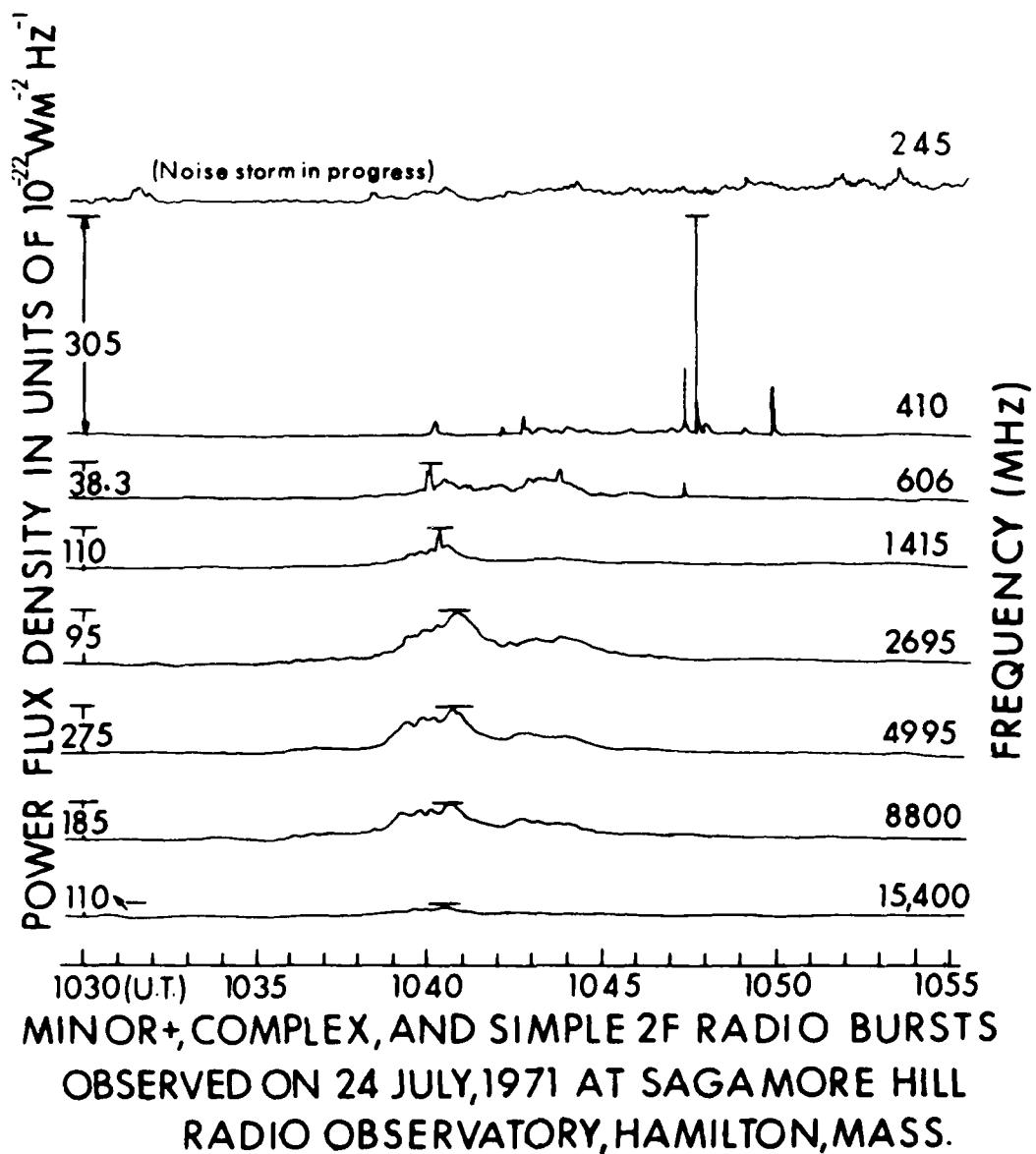
COMPLEX F & SIMPLE 2F RADIO BURST OBSERVED ON
12 MAY 1971 AT MANILA OBSERVATORY, R.P.

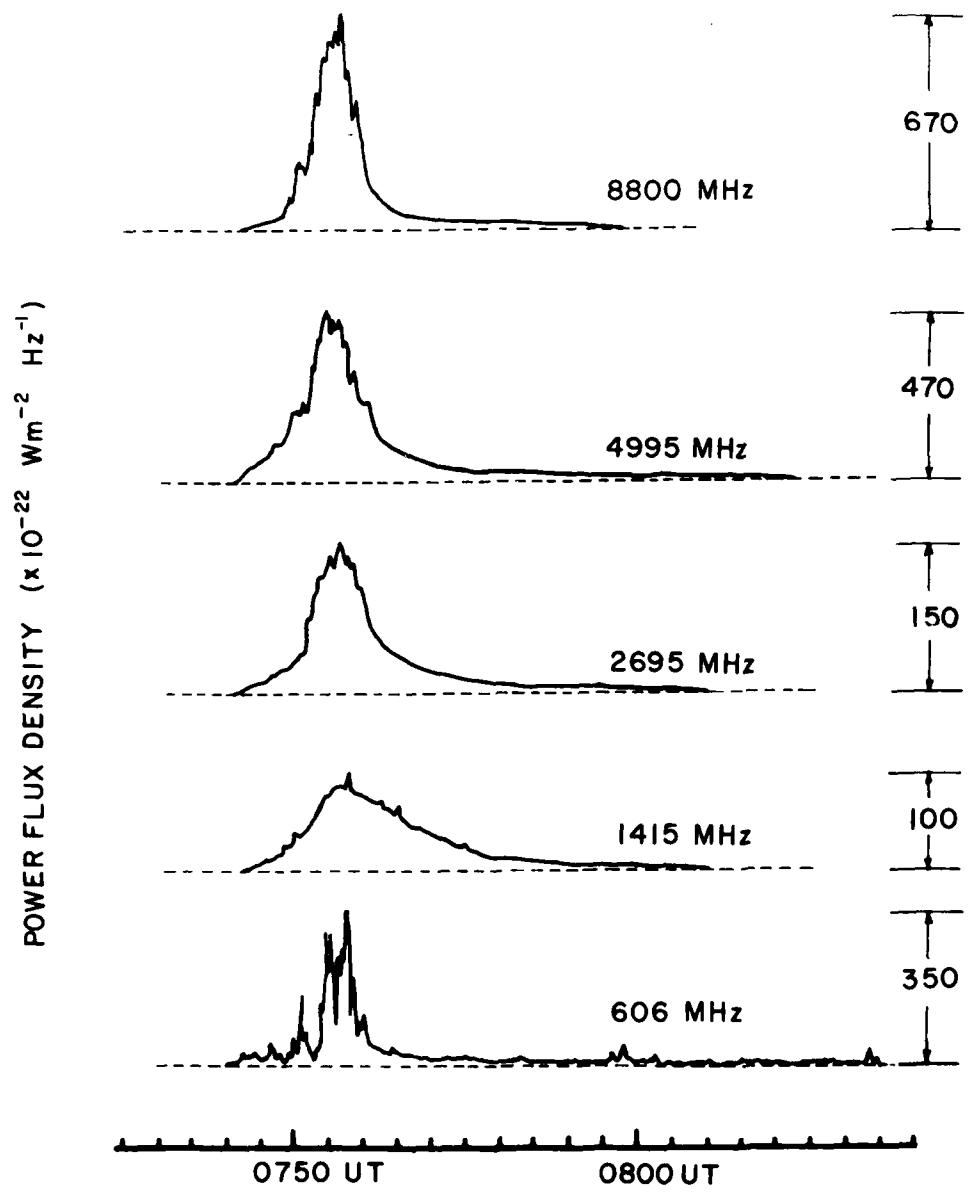




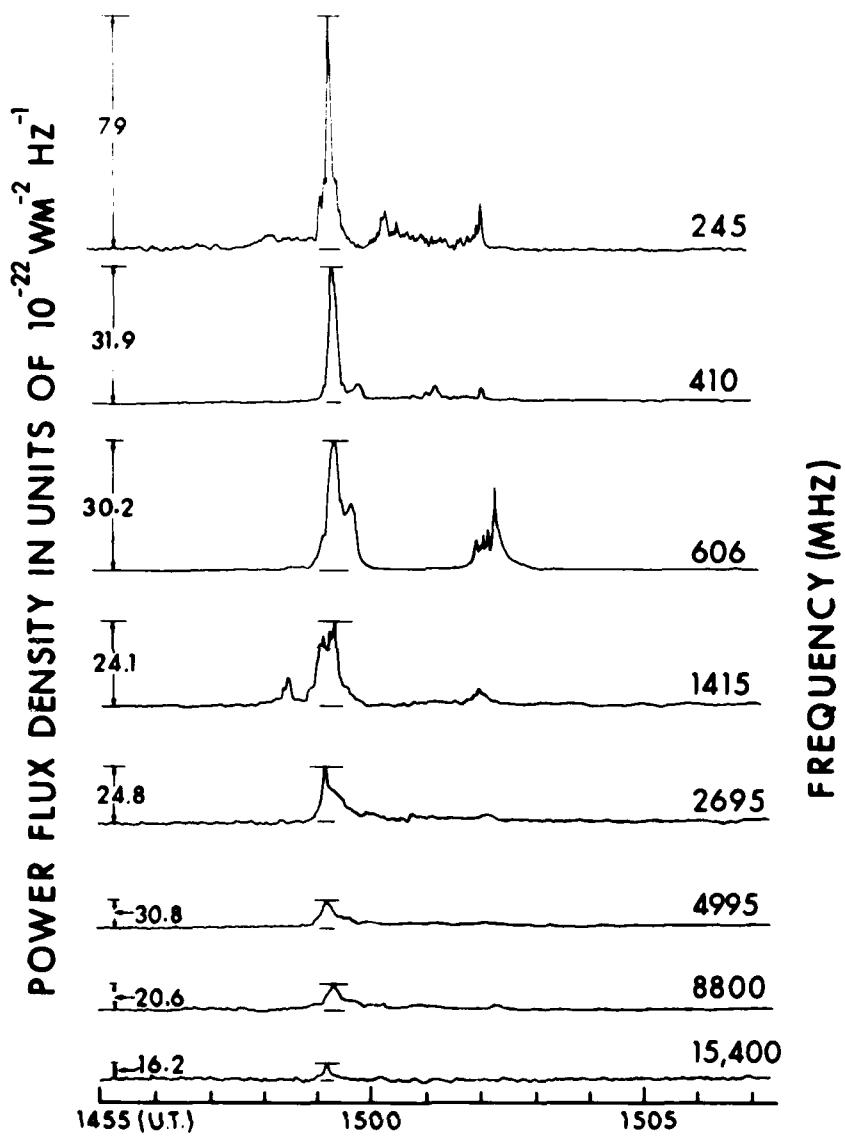


SIMPLE 2F RADIO BURST WITH SPIKES ON 606 MHz
OBSERVED 29 JUNE 1971 AT MANILA OBSERVATORY,
PHILIPPINES.

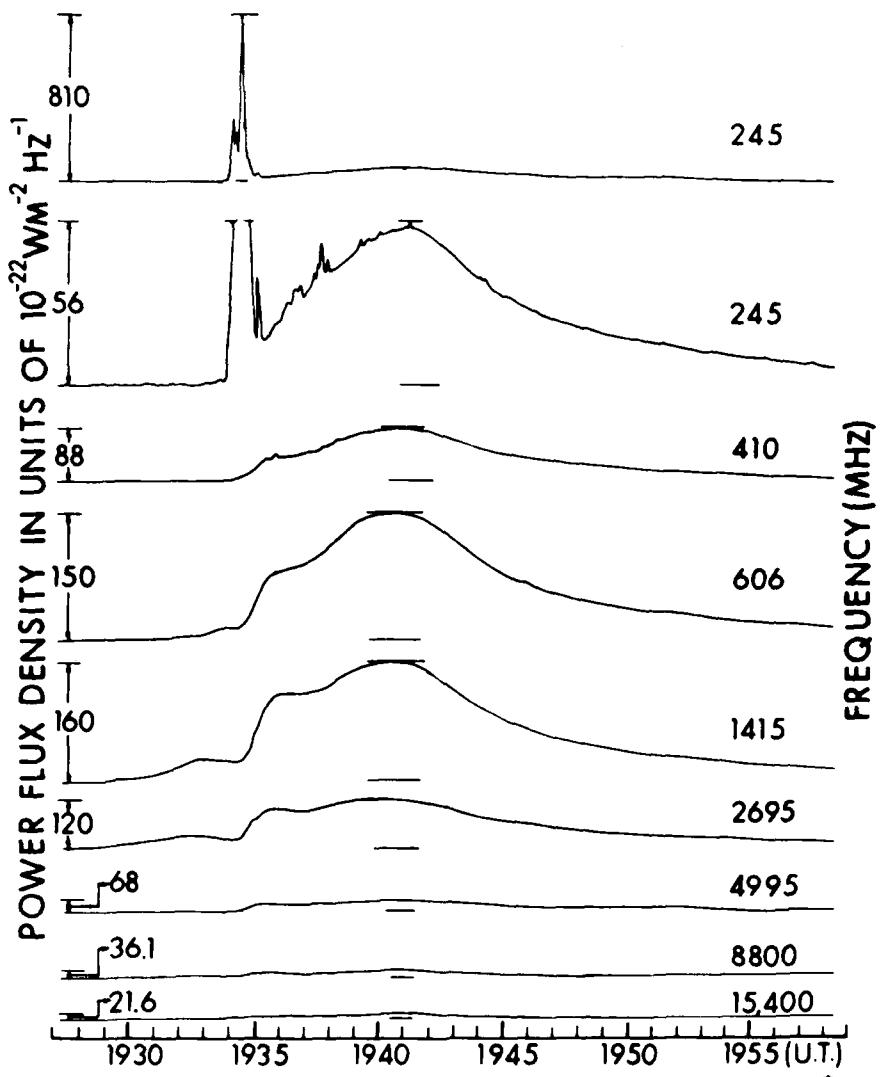




SIMPLE 2F, FLUCTUATIONS & GREAT RADIO BURST
OBSERVED ON 22 AUGUST 1971 AT MANILA OBSERVATORY.

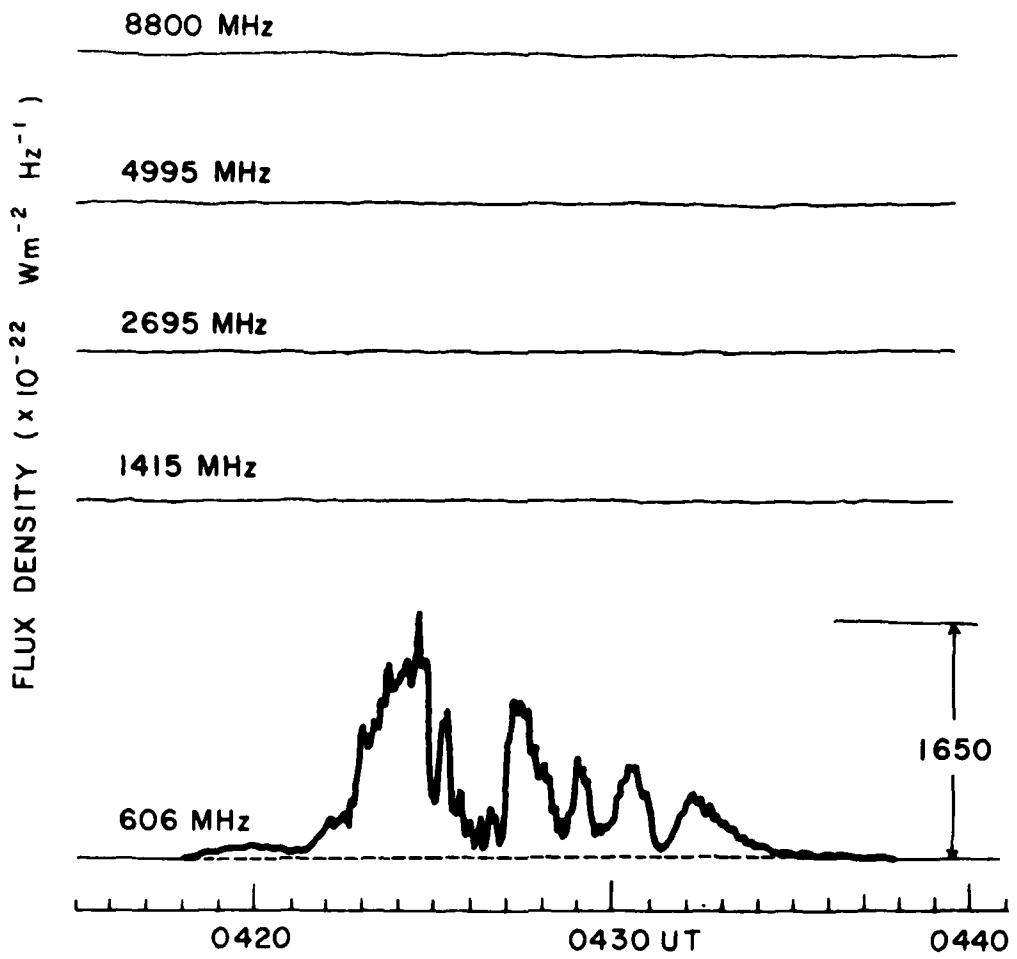


MINOR, COMPLEX, & SIMPLE 2 RADIO BURST
OBSERVED ON 27 AUGUST, 1971 AT
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

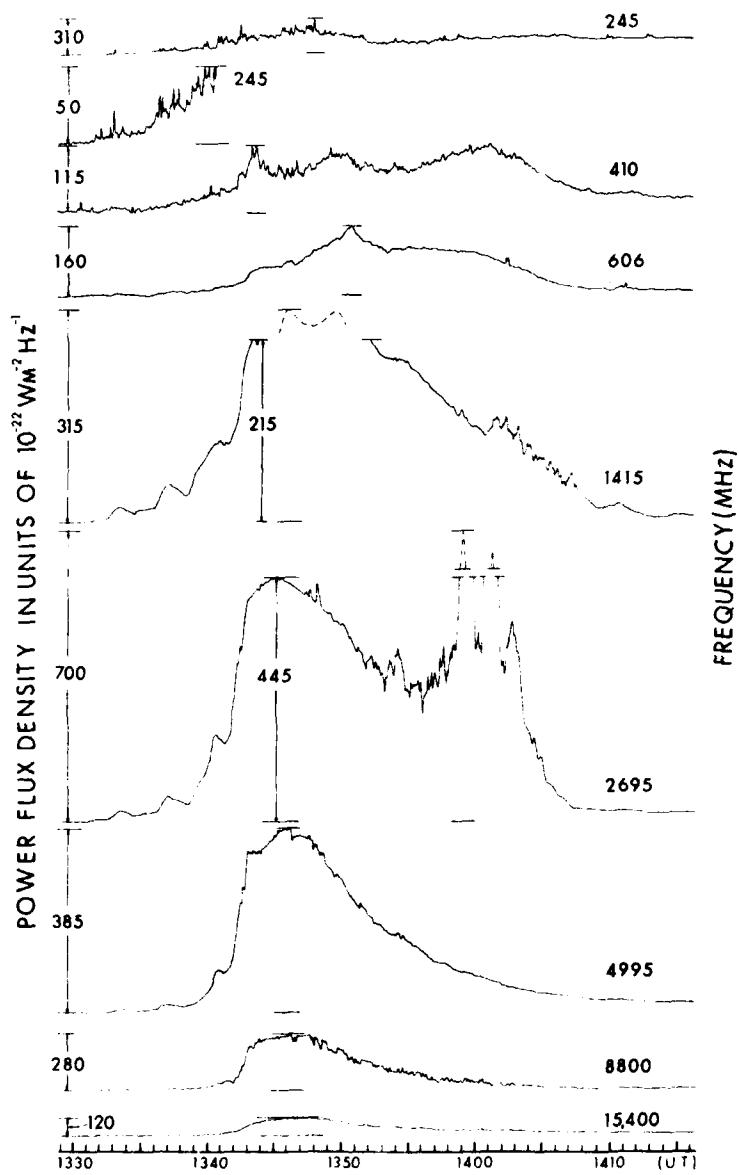


SIMPLE 2F, 3F, MINOR & MAJOR RADIO BURST*
 OBSERVED ON 1 SEPTEMBER, 1971 AT THE
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

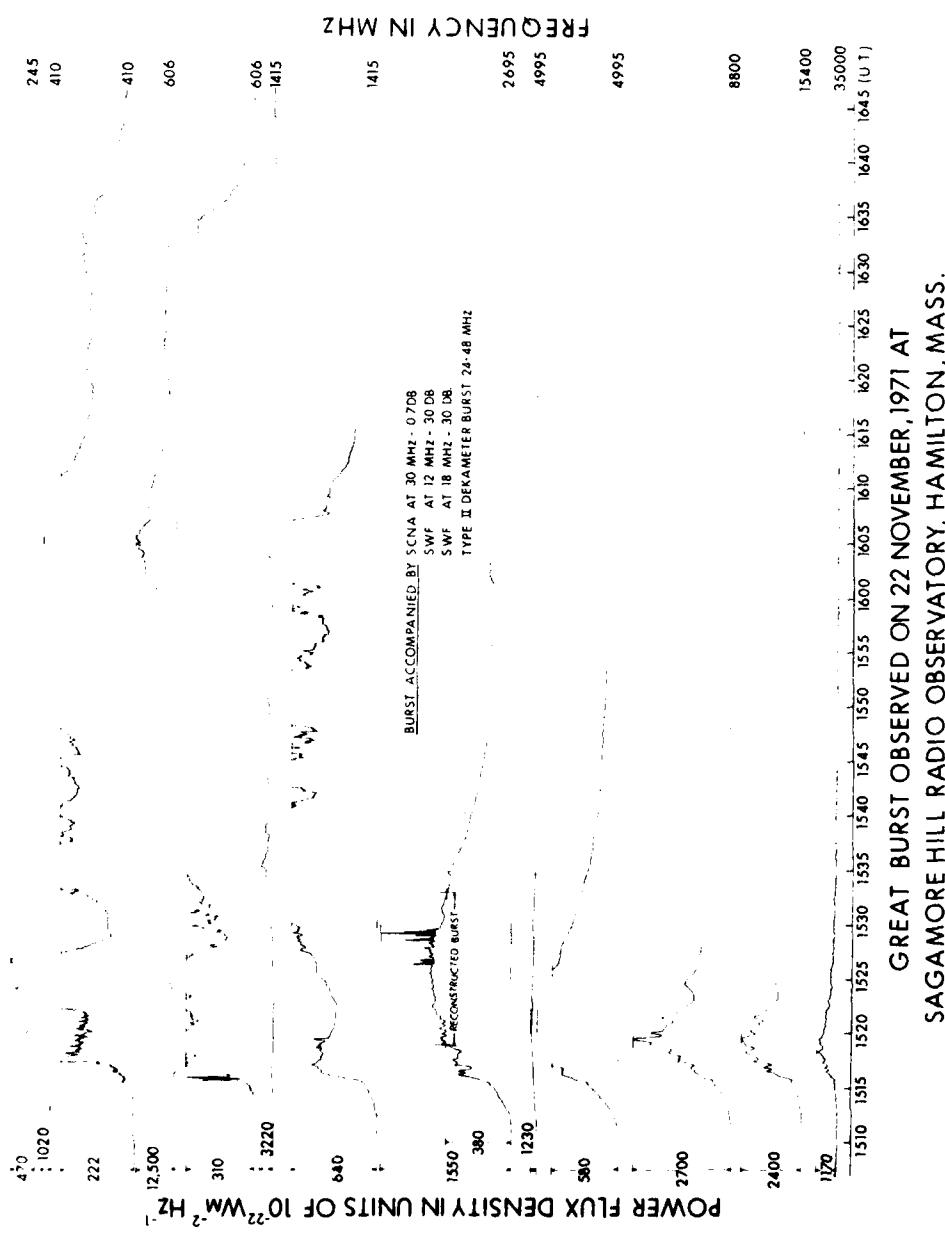
*BEHIND LIMB EVENT



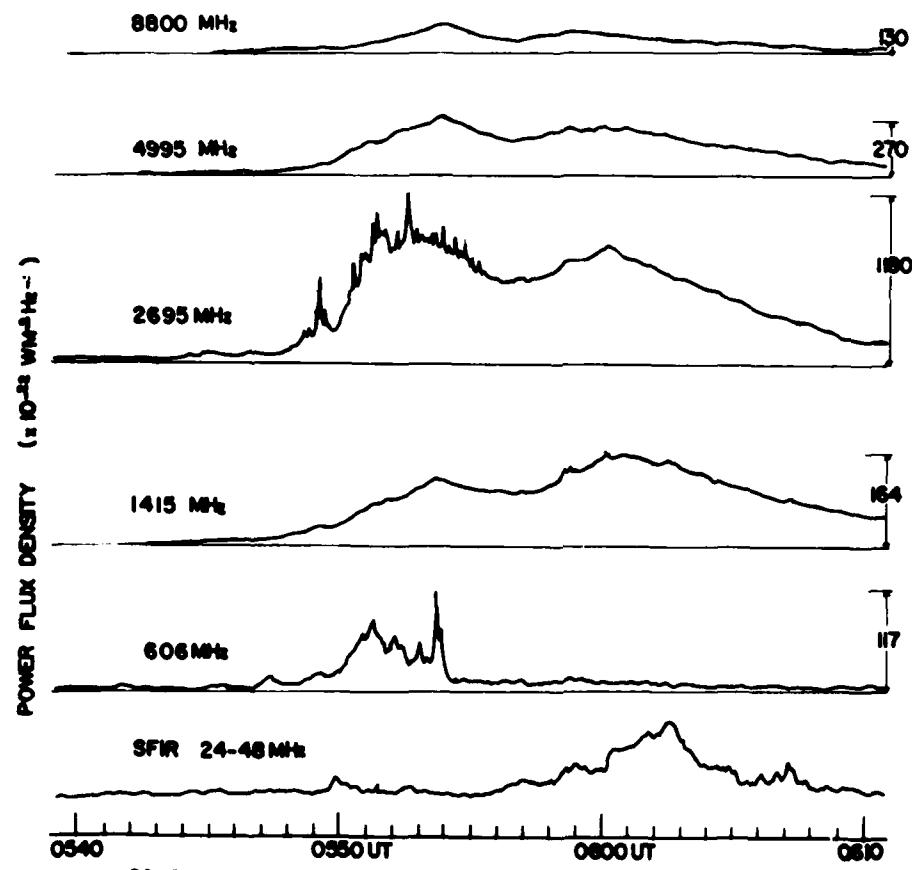
SINGLE FREQUENCY GREAT RADIO BURST ON 606 MHz
OBSERVED AT MANILA OBSERVATORY ON 9 SEPTEMBER 1971

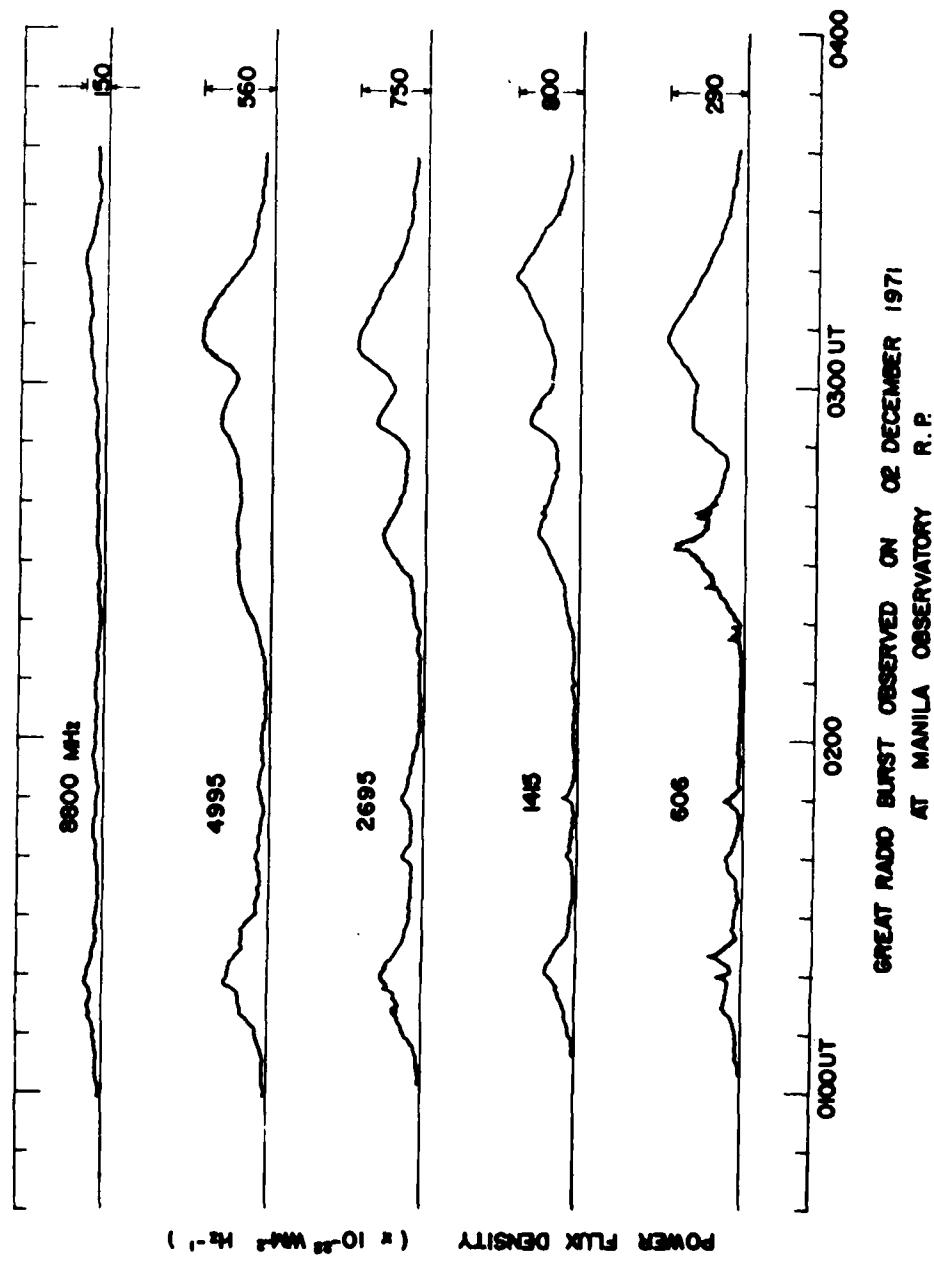


MINOR, MINOR +, GREAT, AND SIMPLE 2F, SIMPLE 2 RADIO BURSTS
 OBSERVED ON 3 OCTOBER, 1971 AT
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

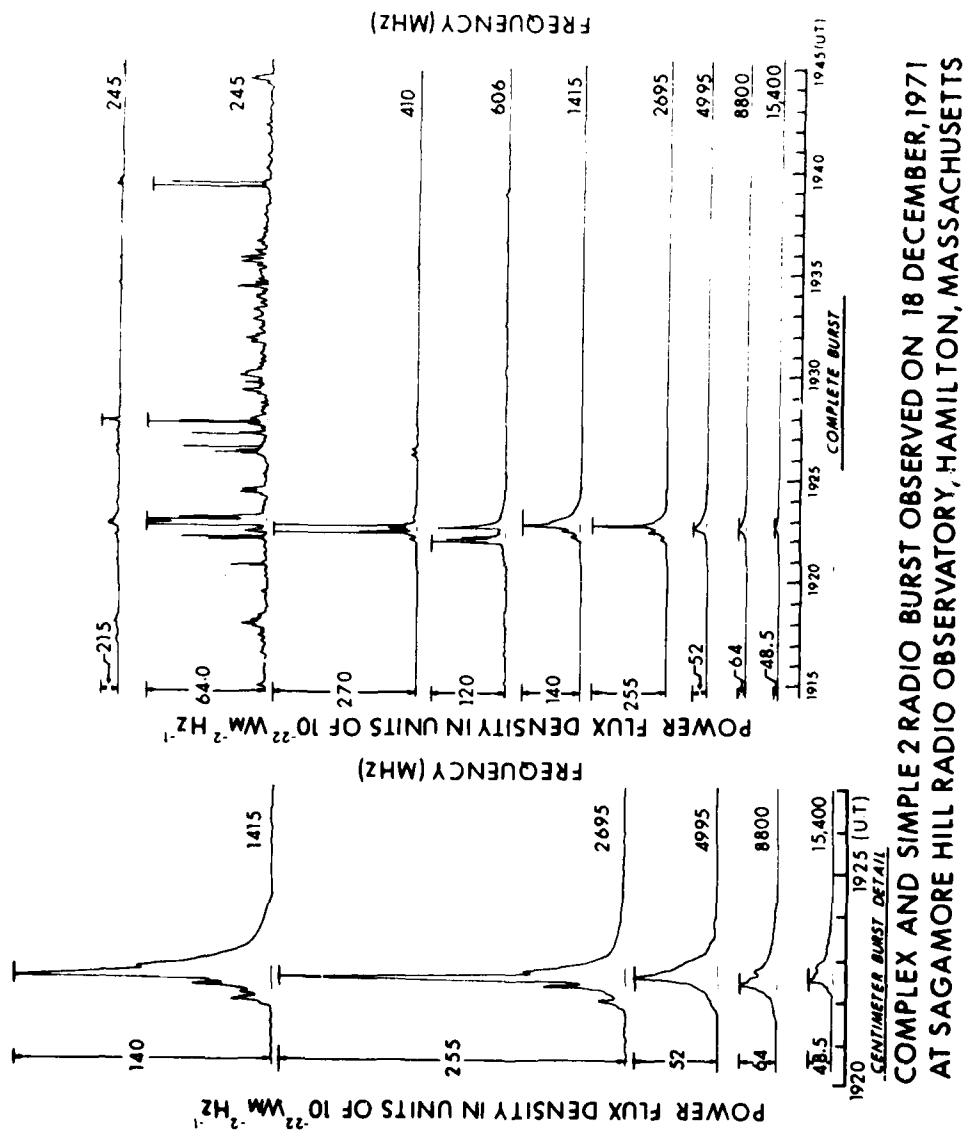


GREAT BURST OBSERVED ON 22 NOVEMBER, 1971 AT
 SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

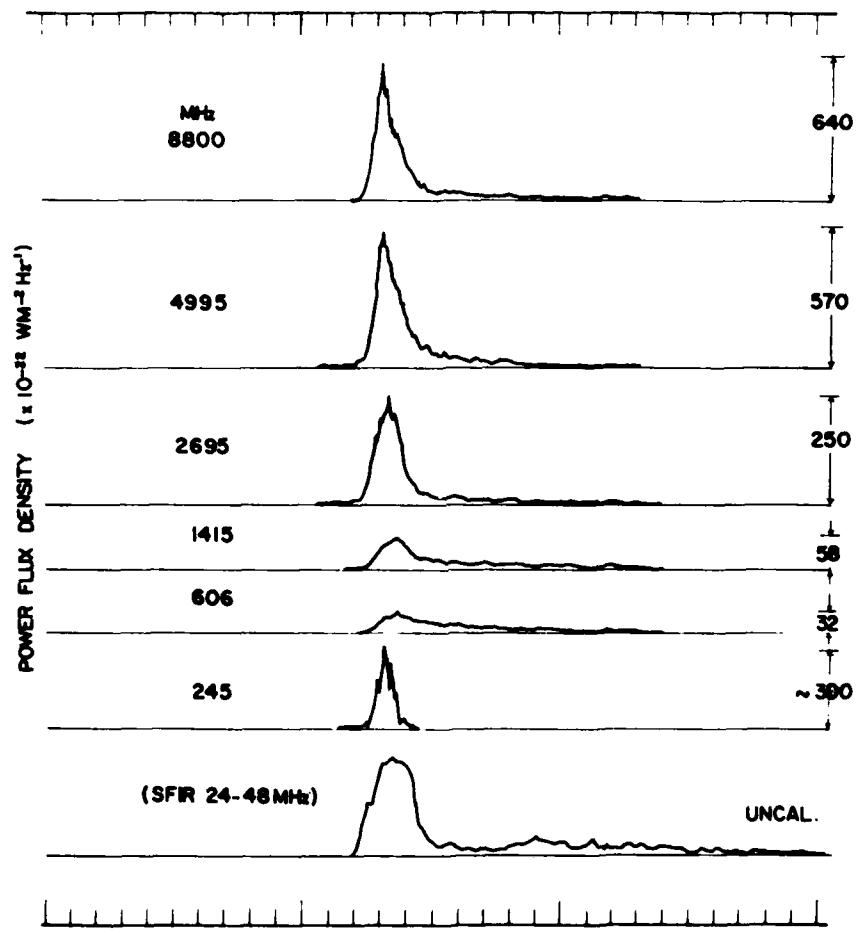




GRATE RADIO BURST OBSERVED ON 02 DECEMBER 1971
AT MANILA OBSERVATORY R.P.



COMPLEX AND SIMPLE 2 RADIO BURST OBSERVED ON 18 DECEMBER, 1971
AT SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASSACHUSETTS

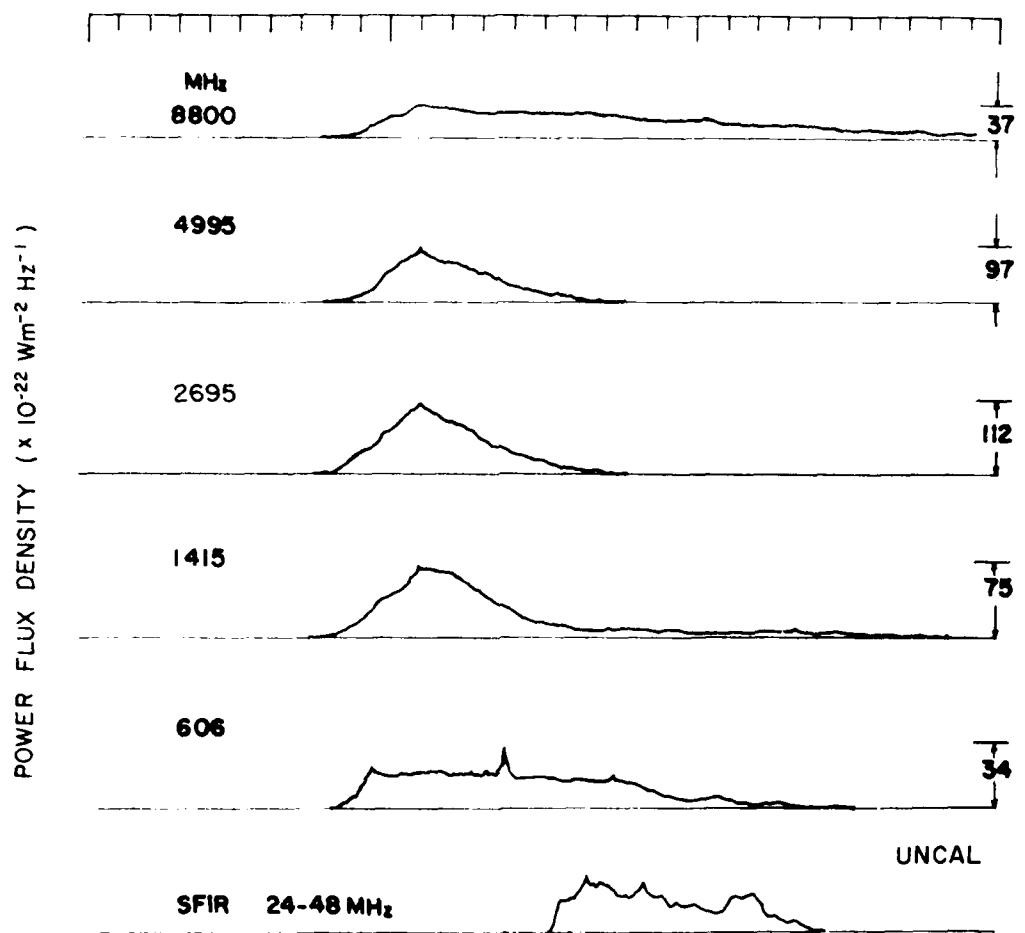


SIMPLE 2F & GREAT RADIO BURST OBSERVED ON
29 DECEMBER 1971 AT MANILA OBSERVATORY, R.P.

RECORDED PAGE BLANK-NOT FILMED

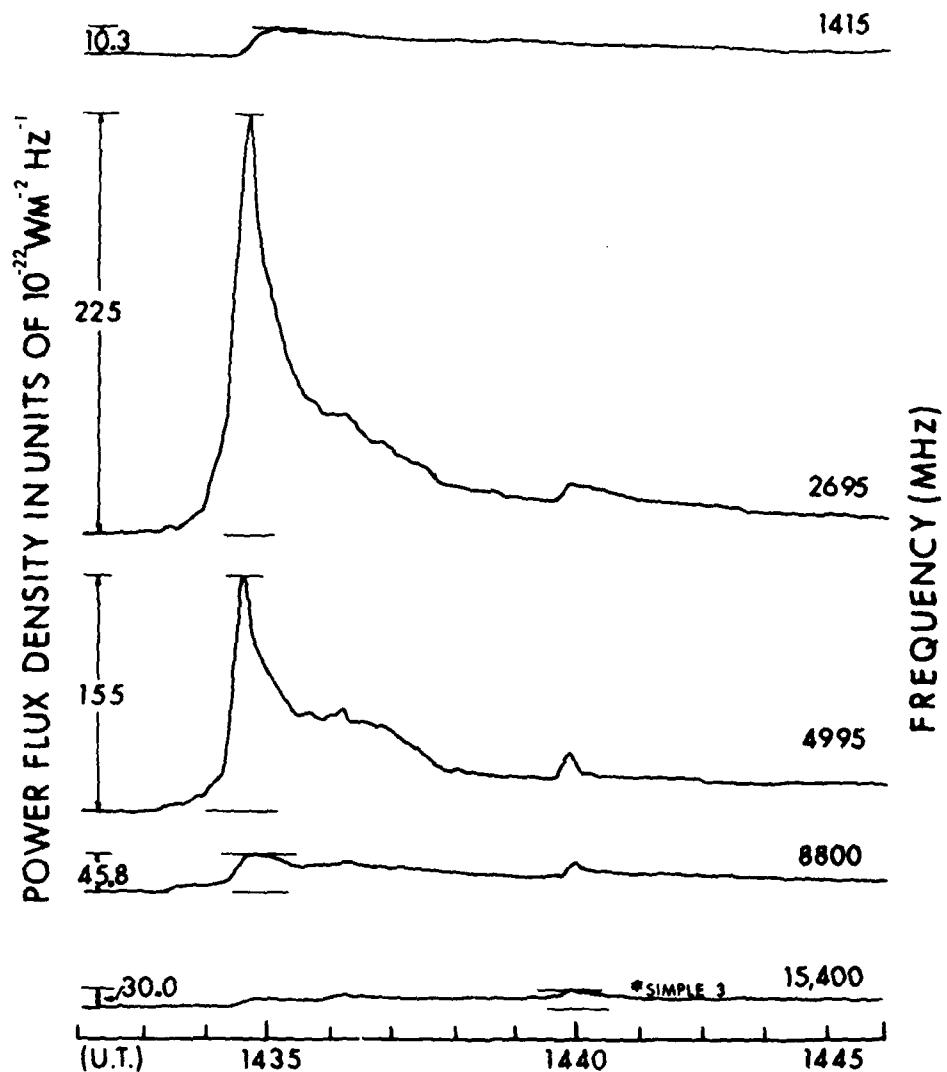
**Solar Radio Bursts
1972**

PRECEDING PAGE BLANK-NOT FILMED

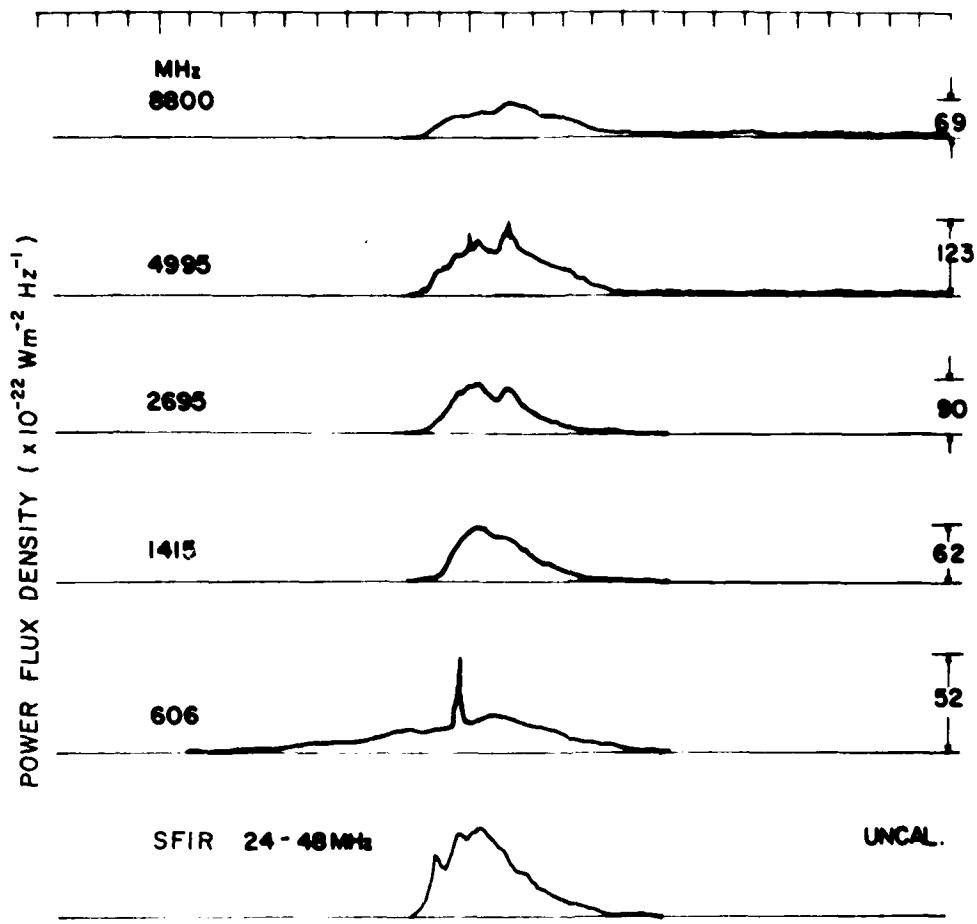


0530 UT 0540 0550 UT 0600

SIMPLE 3 & 2F RADIO BURST OBSERVED ON 22 JANUARY
1972 AT MANILA OBSERVATORY, R.P.

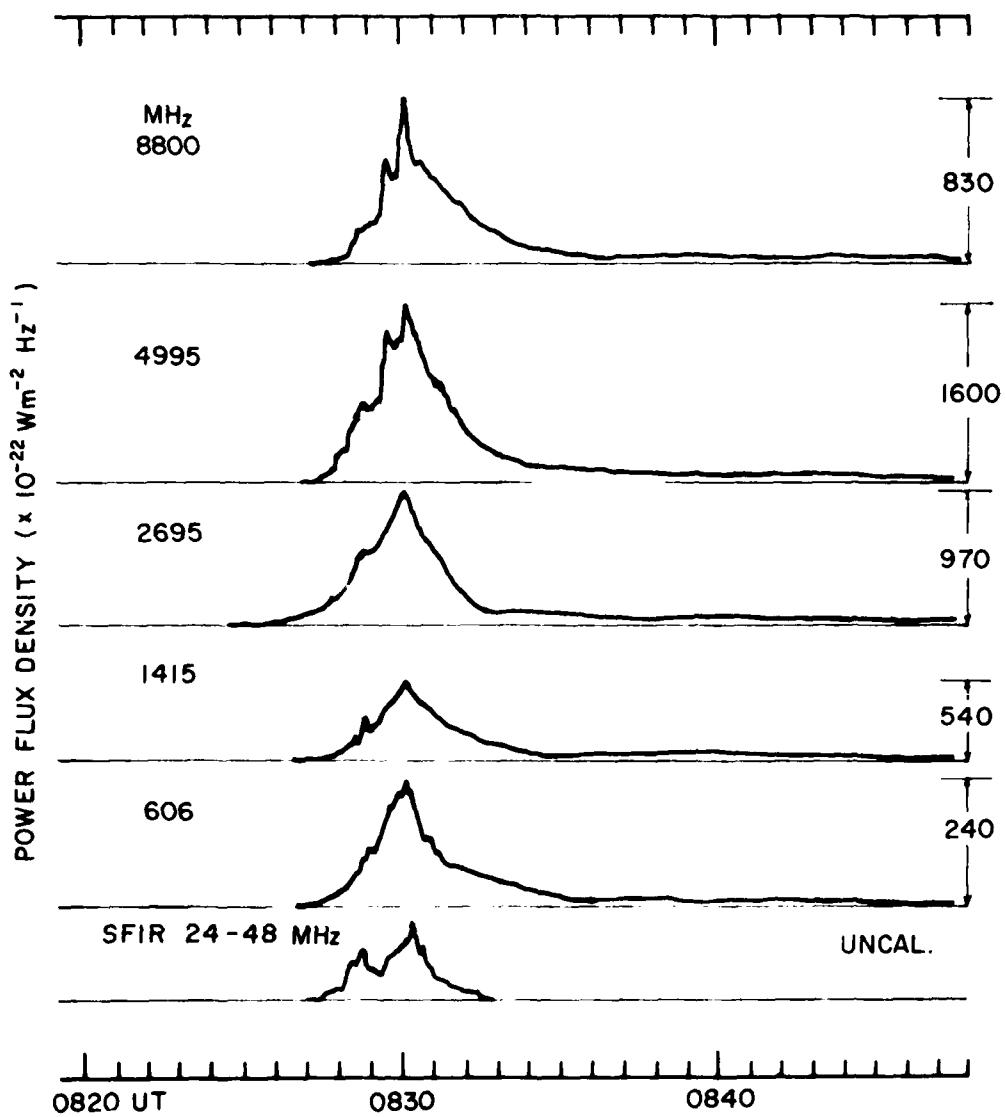


A SIMPLE 2 & 2F* RADIO BURST OBSERVED ON 22 JAN. 1972
 AT SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.

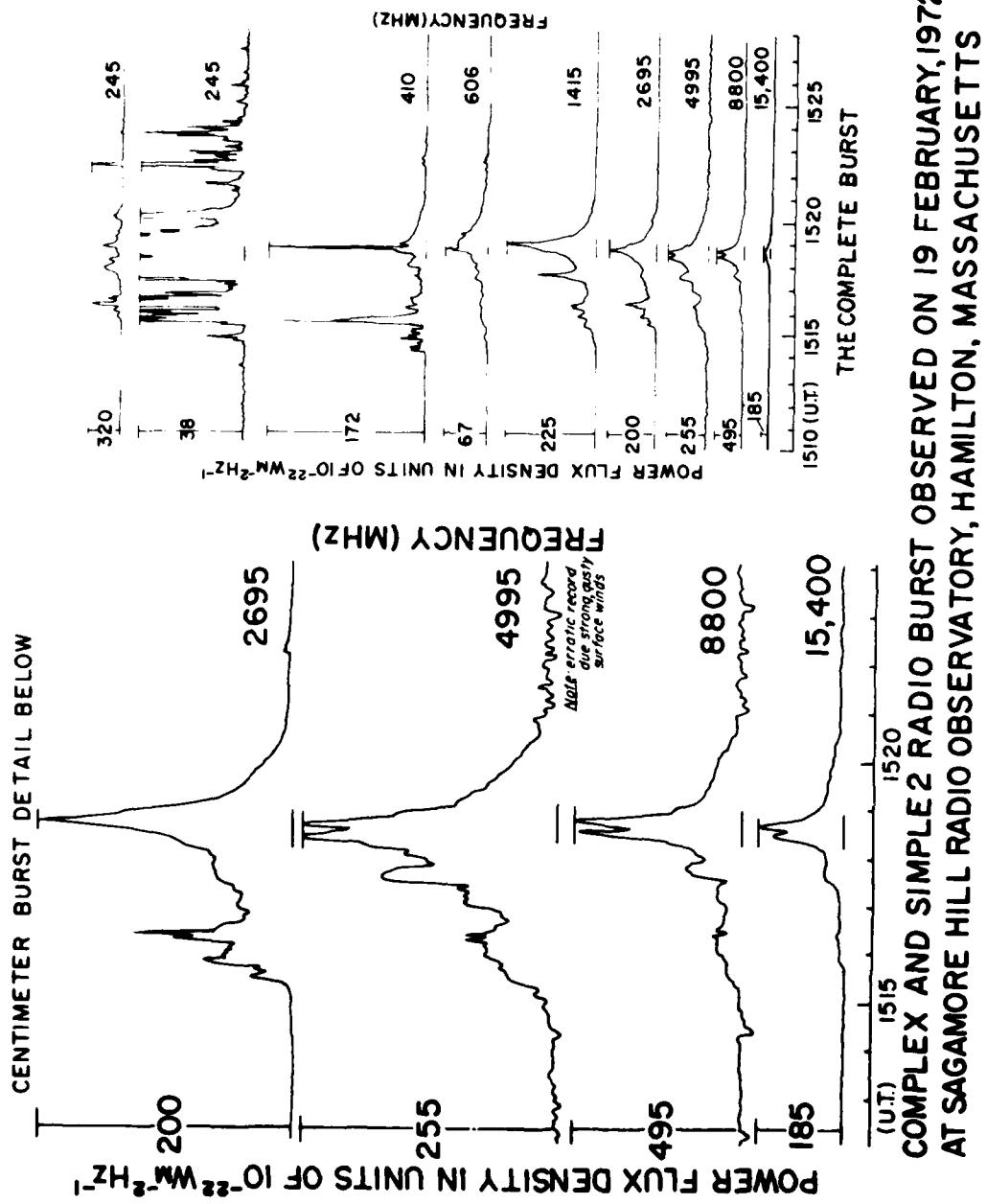


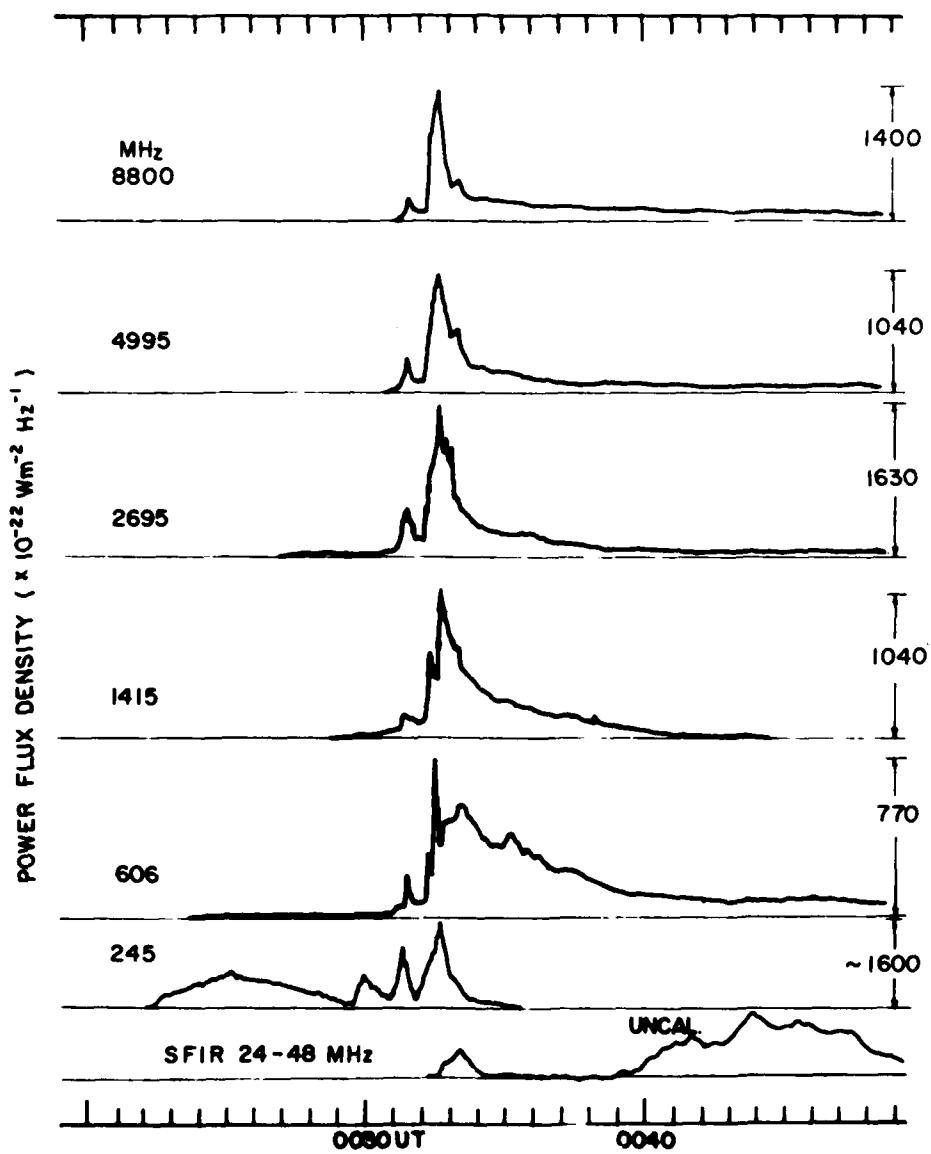
0310 UT 0320 0330

COMPLEX F & SIMPLE 2F RADIO BURST OBSERVED ON
23 JANUARY 1972 AT MANILA OBSERVATORY, R.P.

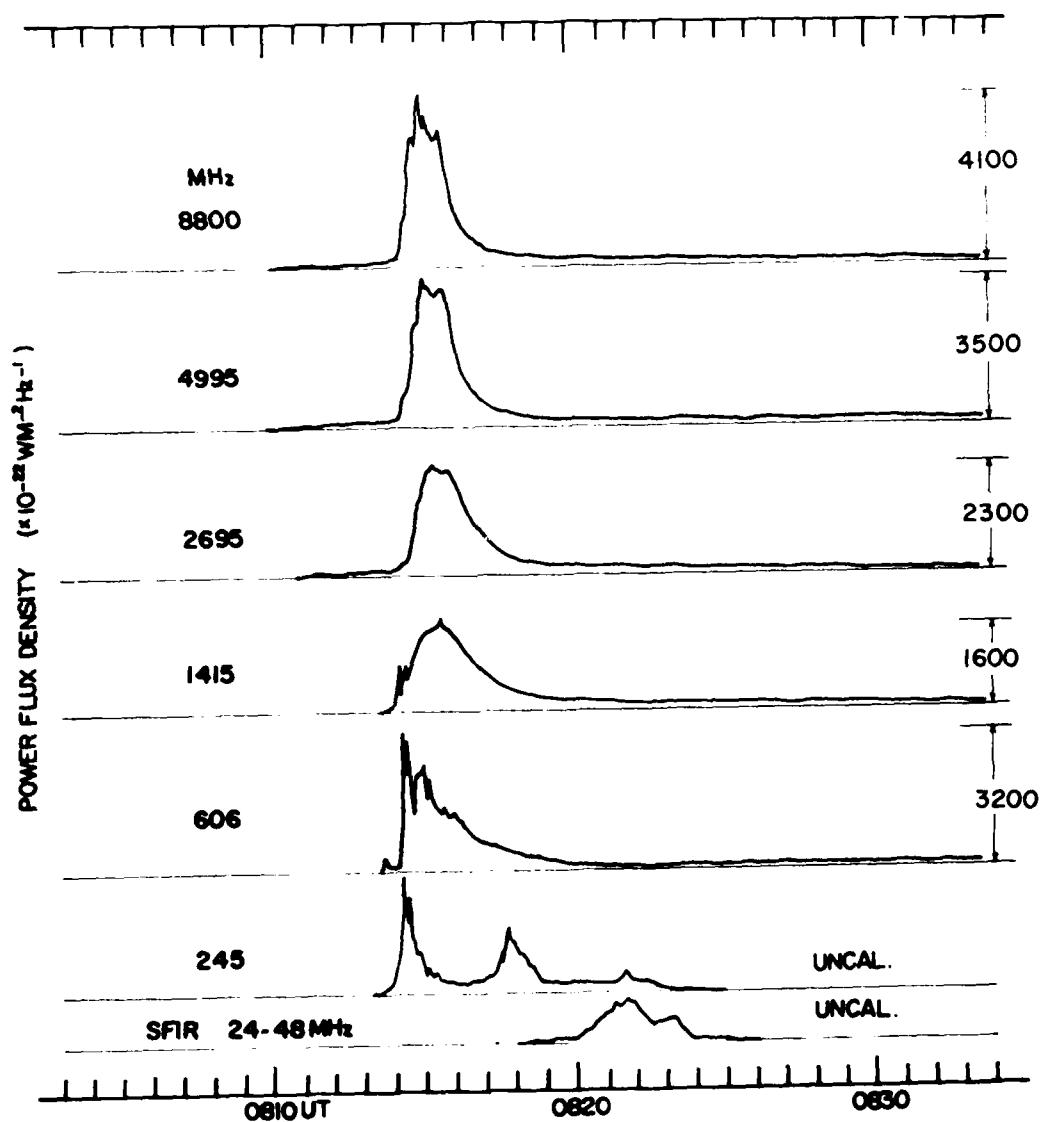


SIMPLE 2F & GREAT RADIO BURST OBSERVED ON
13 FEBRUARY 1972 AT MANILA OBSERVATORY, R. P.

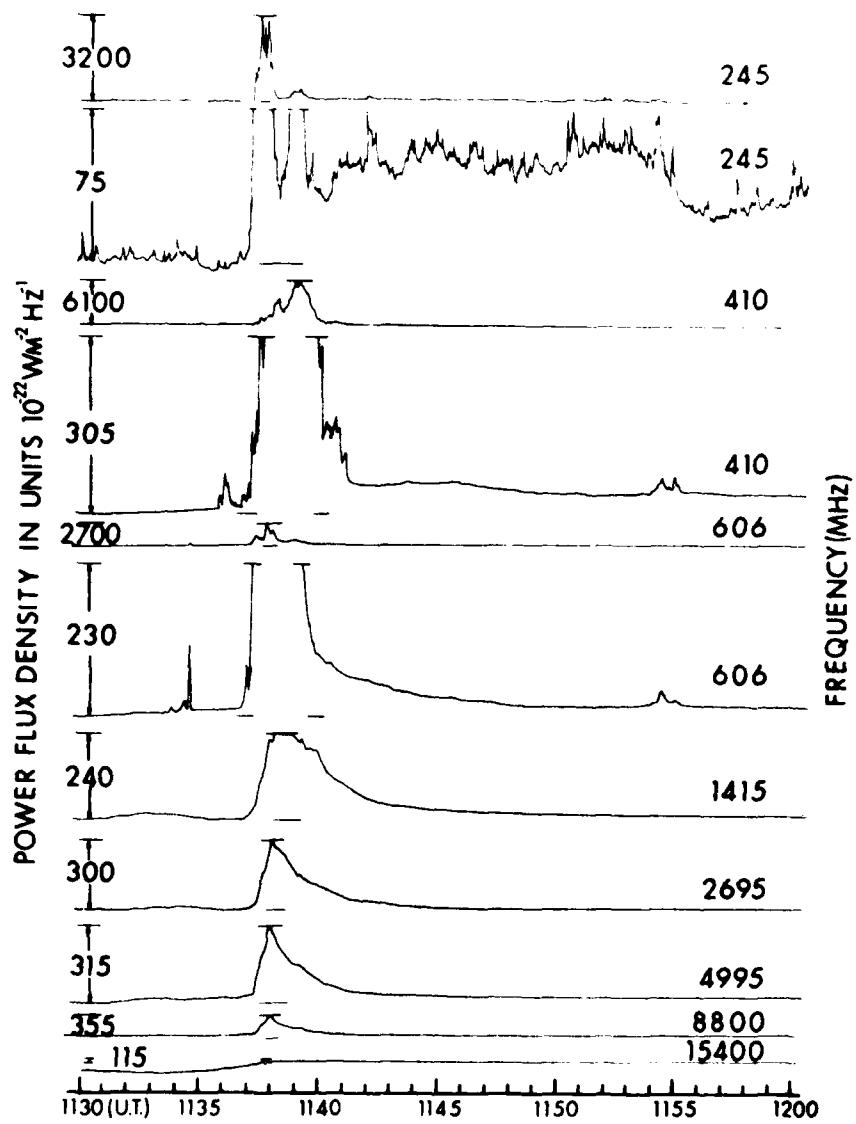




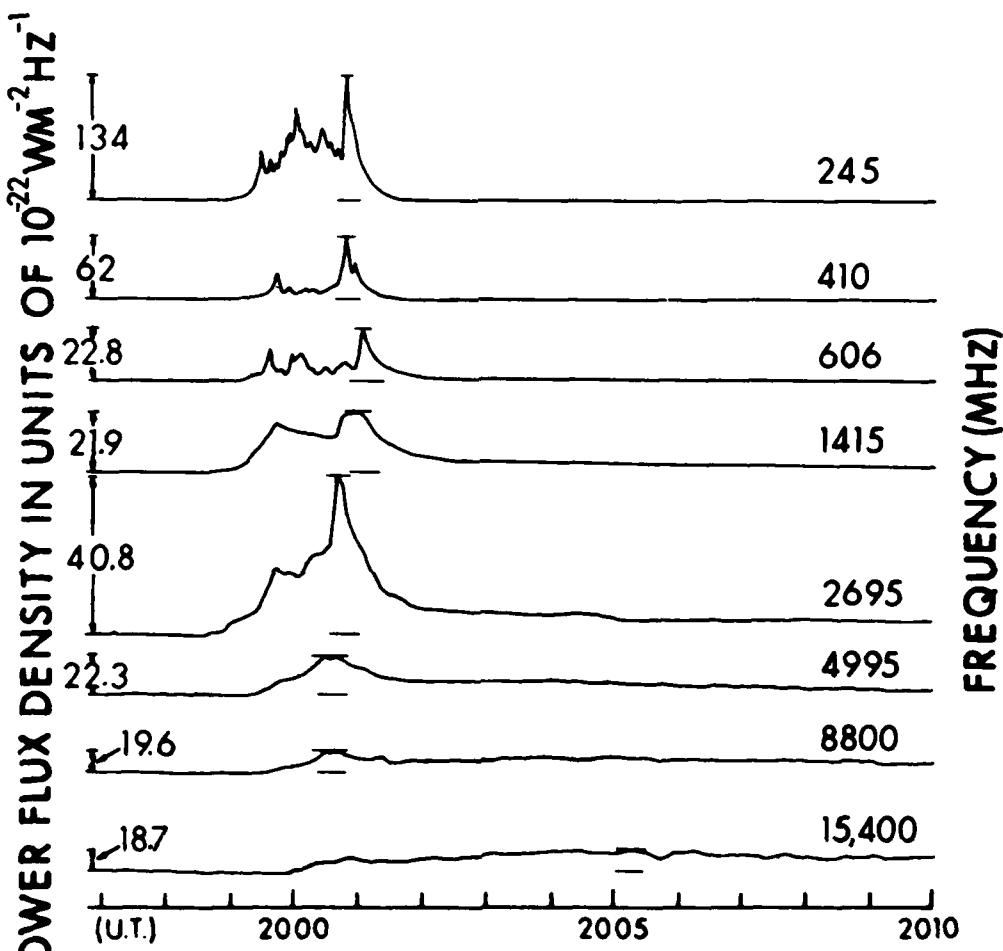
GREAT RADIO BURST OBSERVED ON 22 FEBRUARY 1972 AT
MANILA OBSERVATORY, R.P.



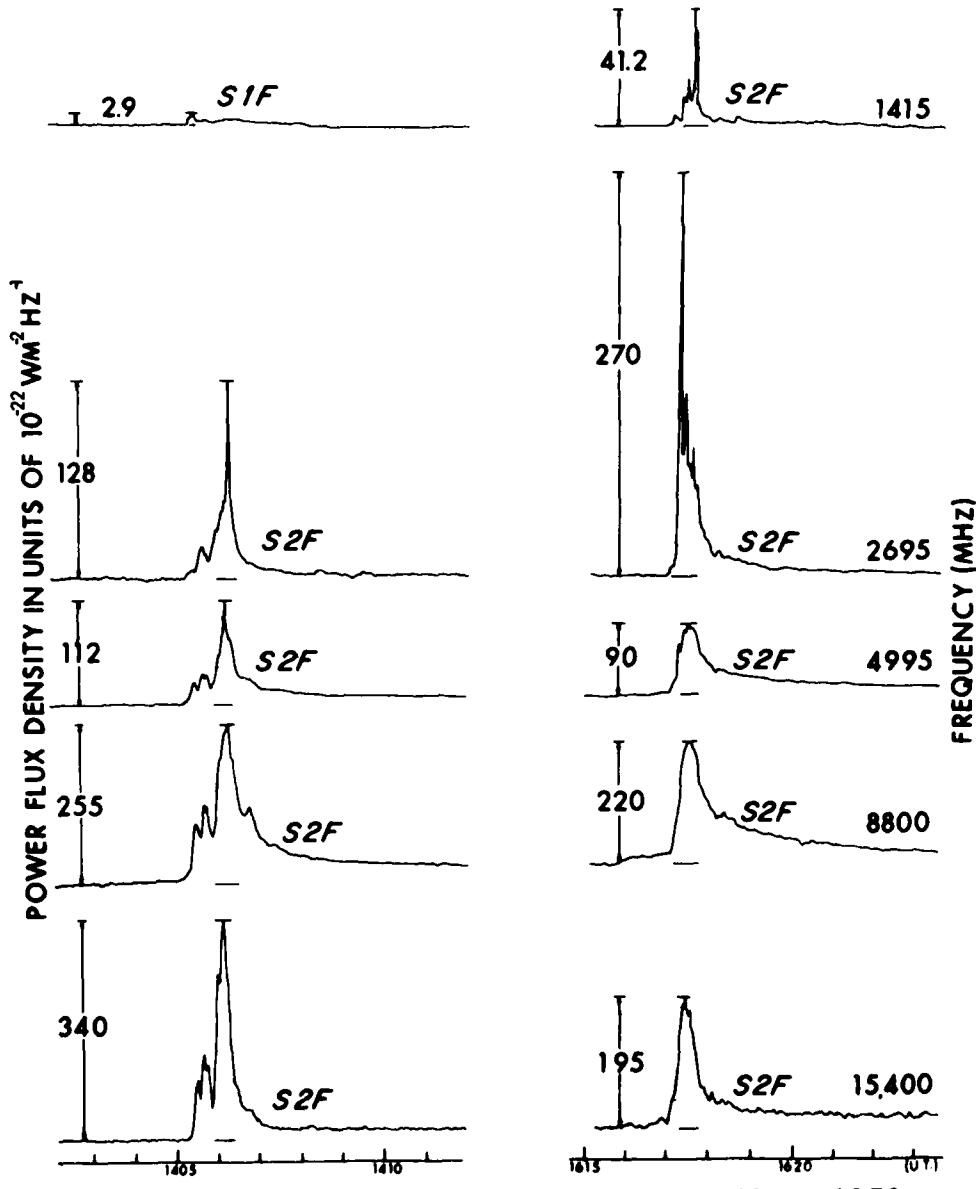
GREAT RADIO BURST OBSERVED ON 05 MARCH 1972
AT MANILA OBSERVATORY, R.P.



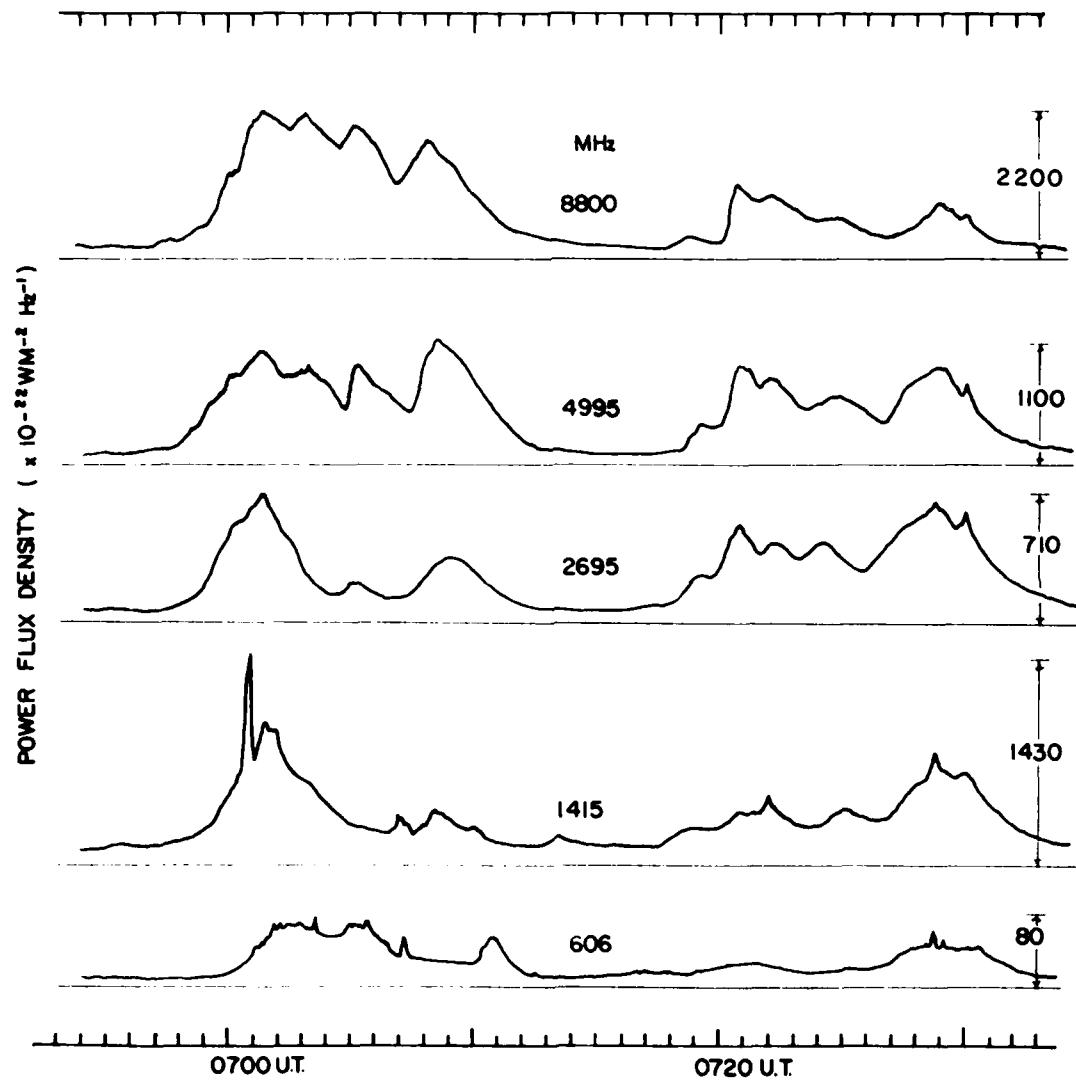
MAJOR+, GREAT, AND SIMPLE 2 RADIO BURST OBSERVED
5 MARCH, 1972 AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



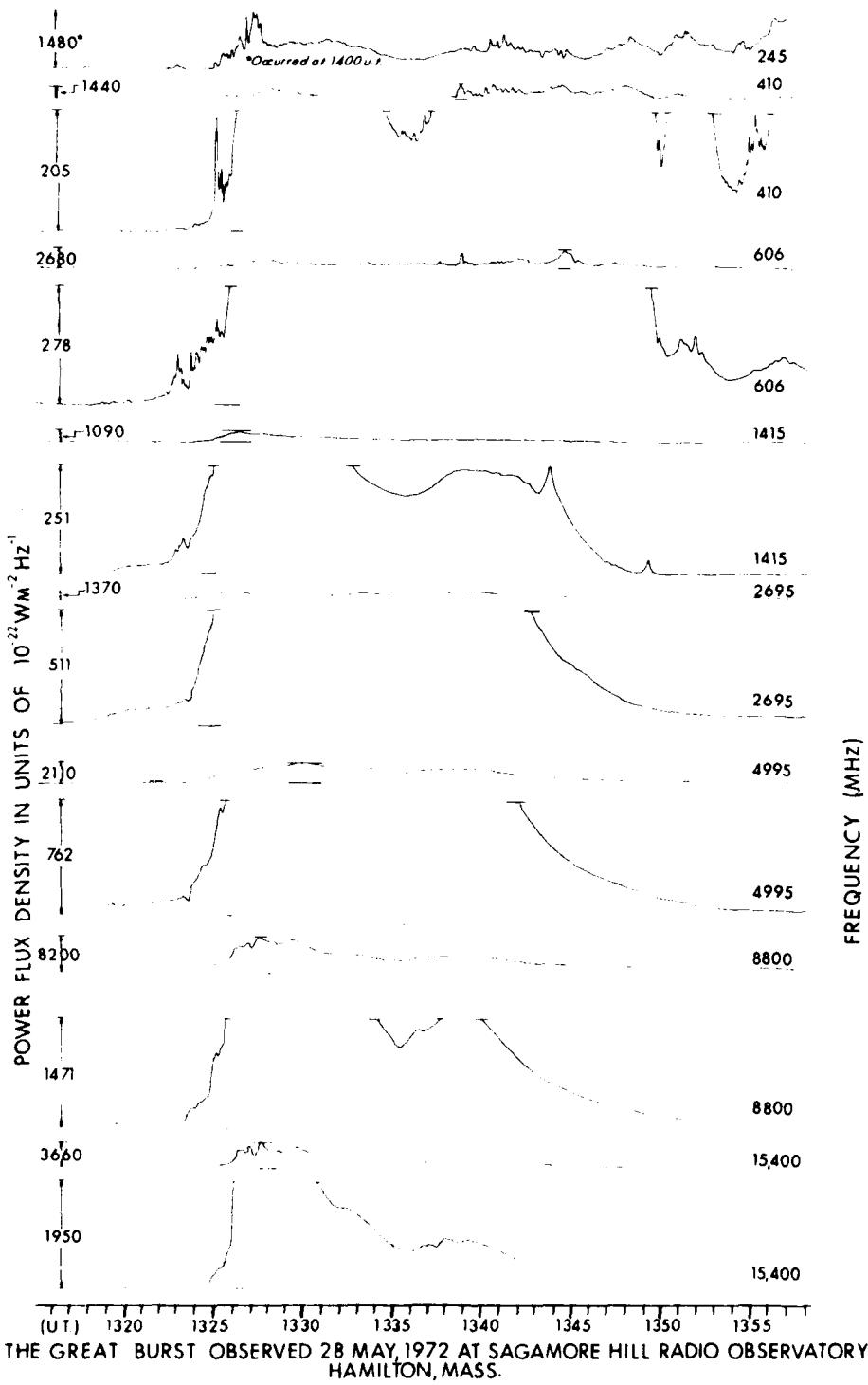
**SIMPLE 2F AND 3F RADIO BURST
OBSERVED 14 APRIL, 1972
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.**



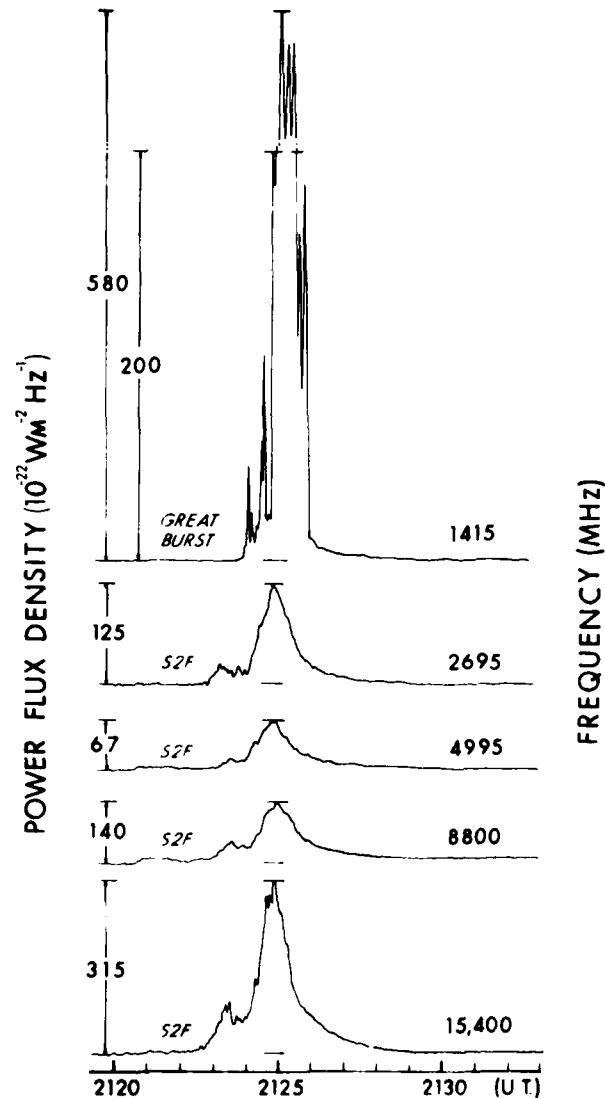
SIMPLE 2F AND 1F RADIO BURSTS OBSERVED ON 18 MAY, 1972
SAGAMORE HILL RADIO OBSERVATORY - HAMILTON, MASS.



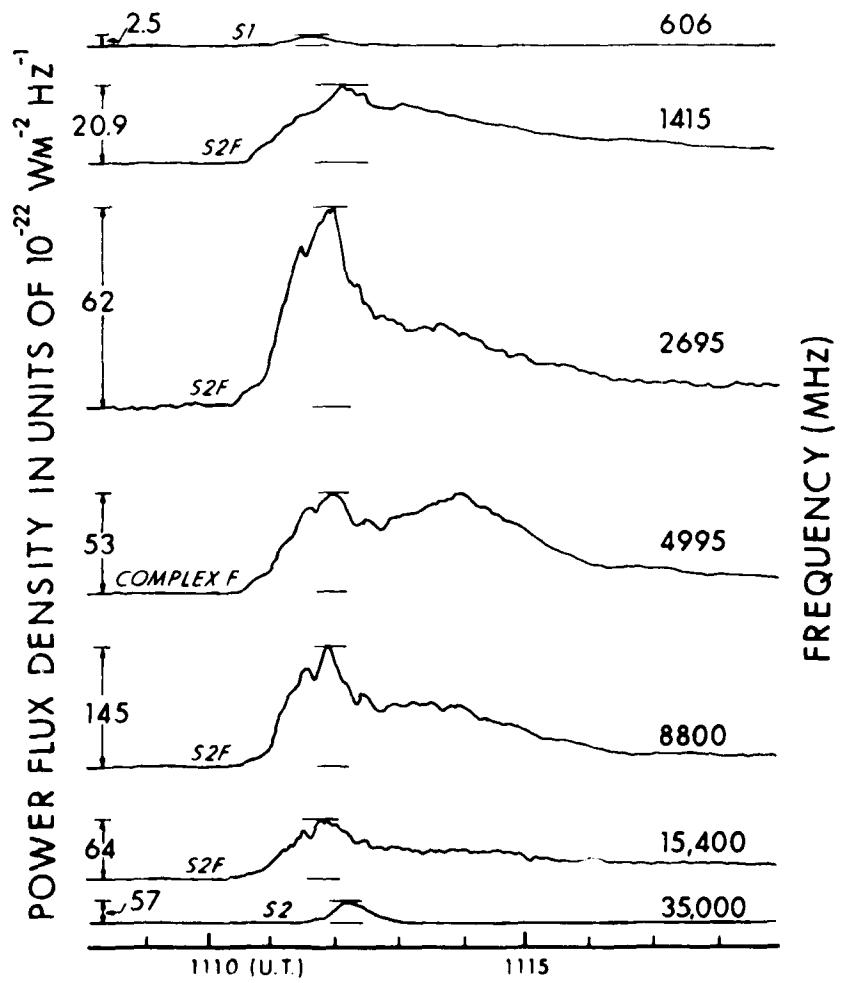
GREAT RADIO BURST OBSERVED ON 24 MAY 1972 AT
MANILA OBSERVATORY, R.P.



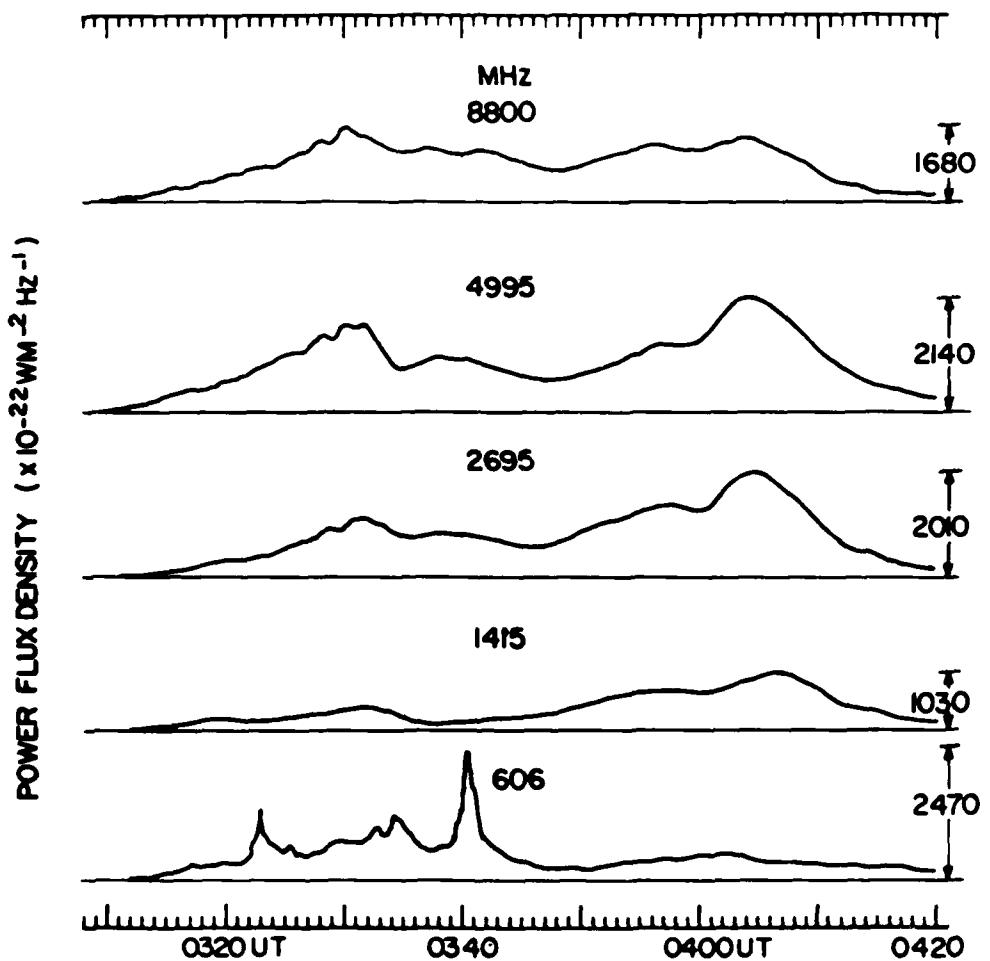
THE GREAT BURST OBSERVED 28 MAY, 1972 AT SAGAMORE HILL RADIO OBSERVATORY
HAMMOND, MASS.



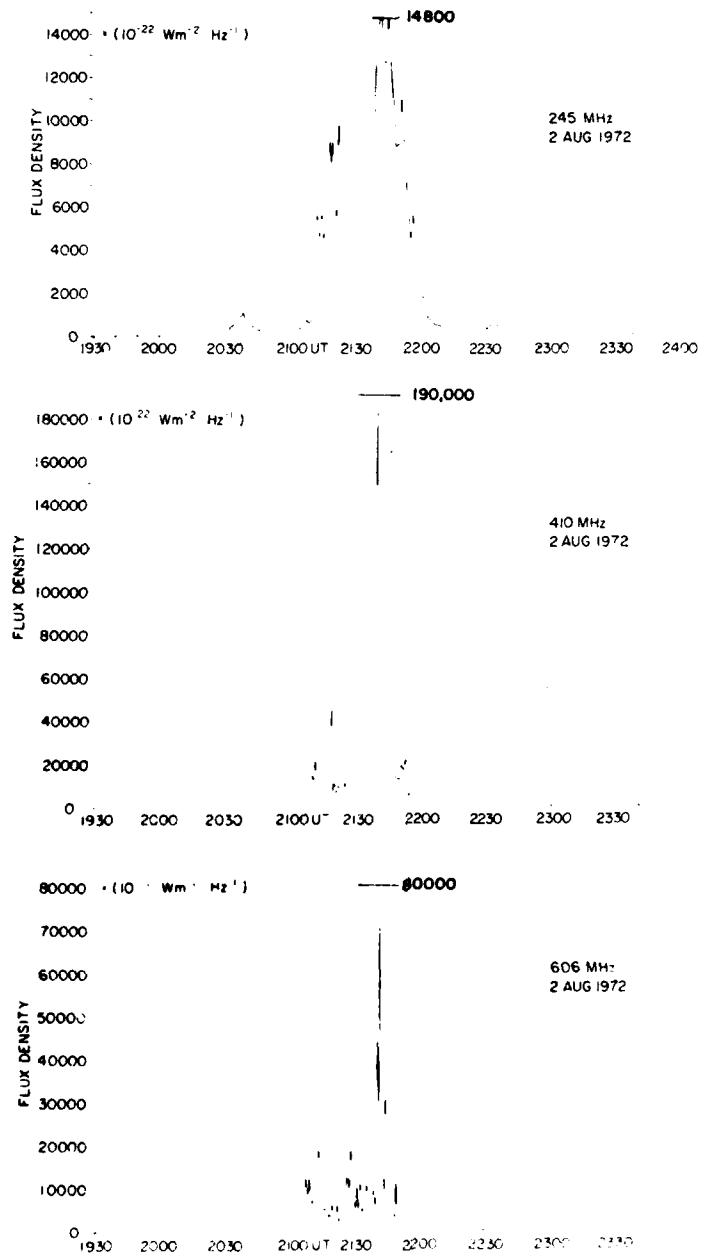
RADIO BURST OBSERVED 5 JUNE, 1972
SAGAMORE HILL RADIO OBSERVATORY
AT HAMILTON, MASS

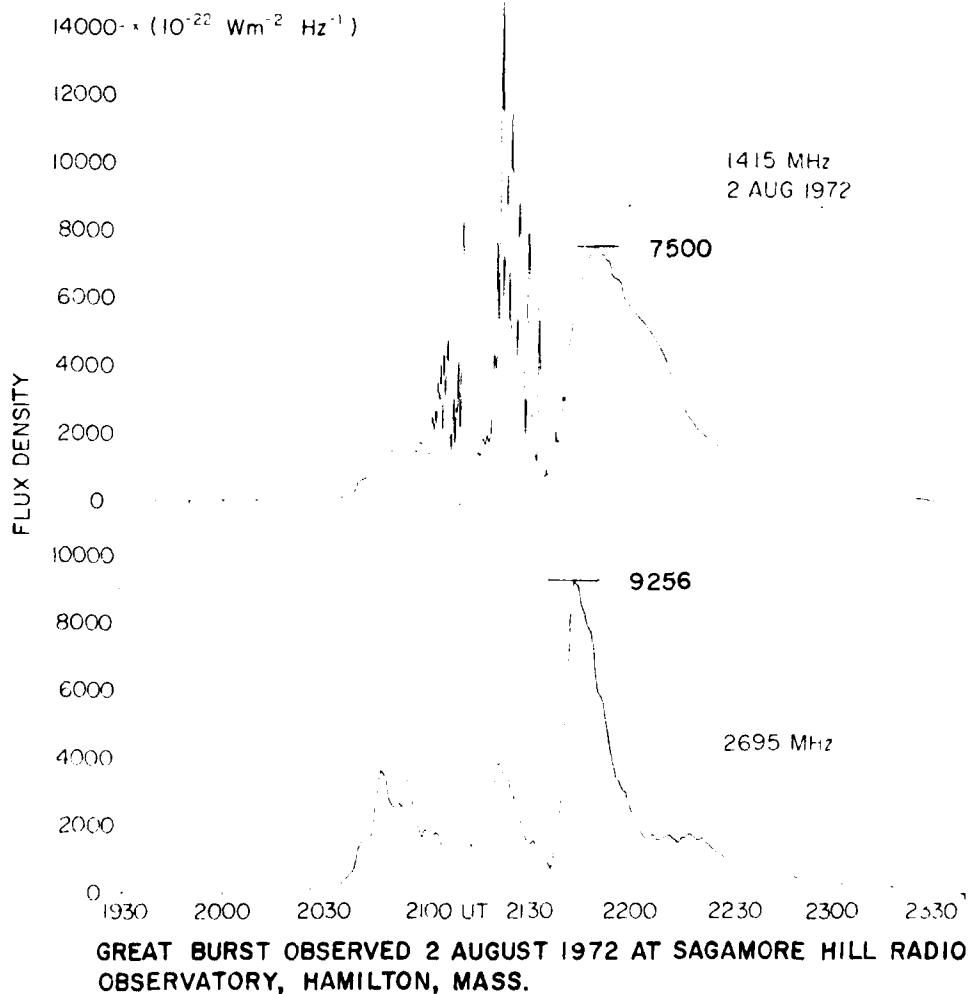


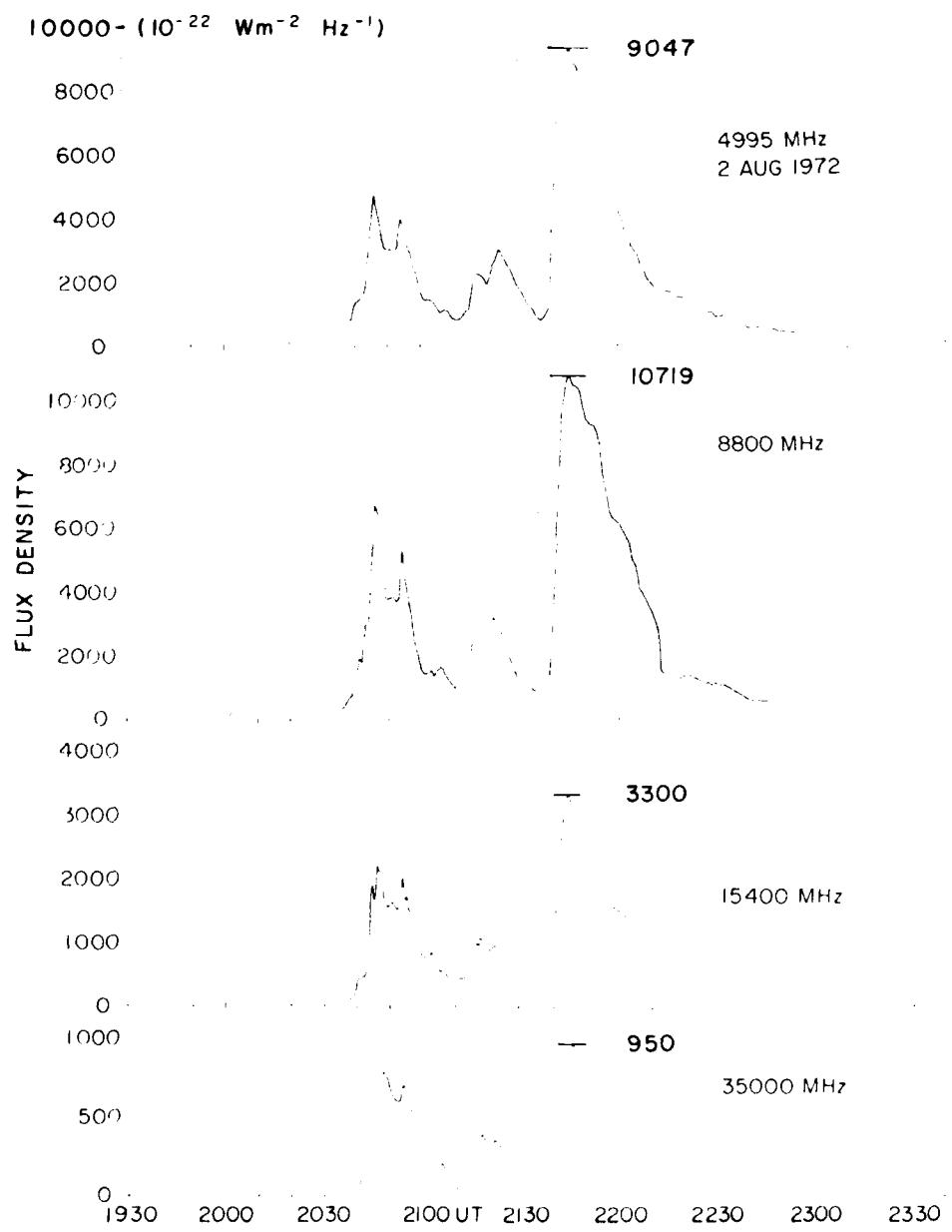
RADIO BURST OBSERVED 31 JULY, 1972
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.



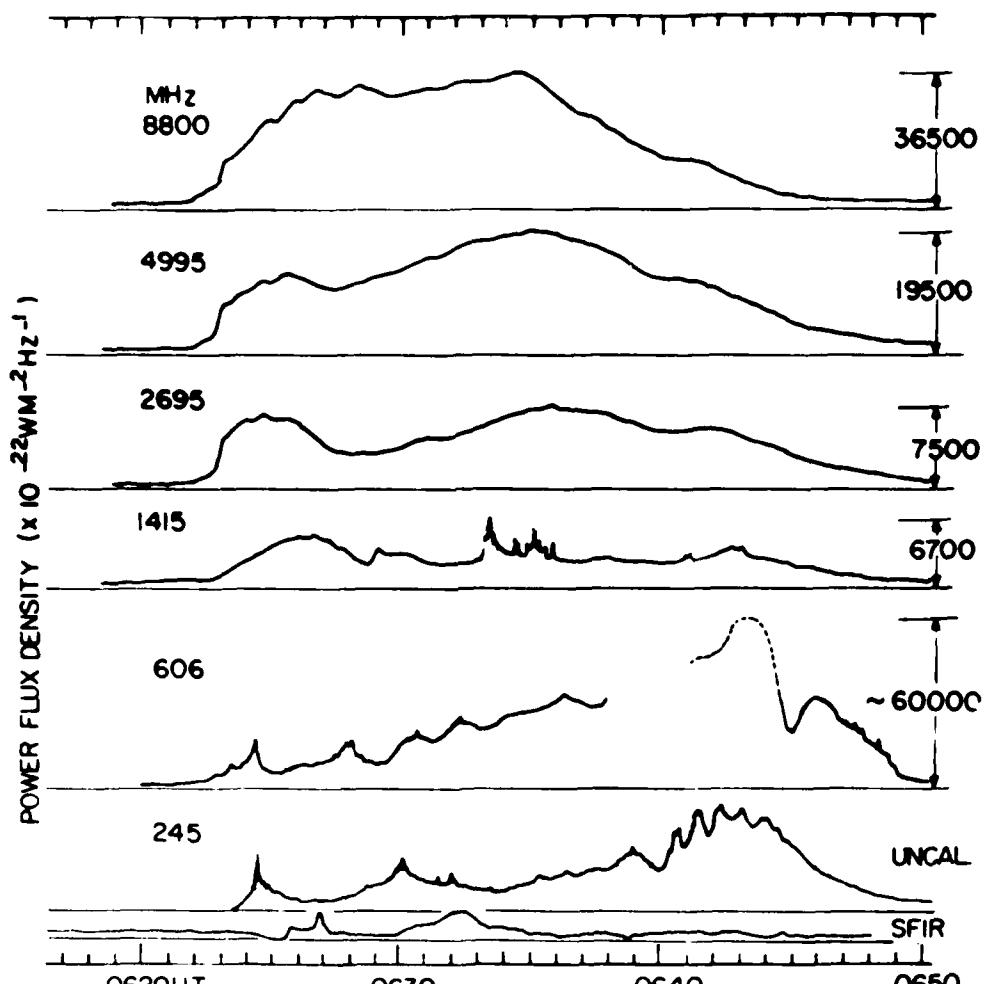
GREAT RADIO BURST OBSERVED ON 02 AUGUST 1972
AT MANILA OBSERVATORY, R.P.



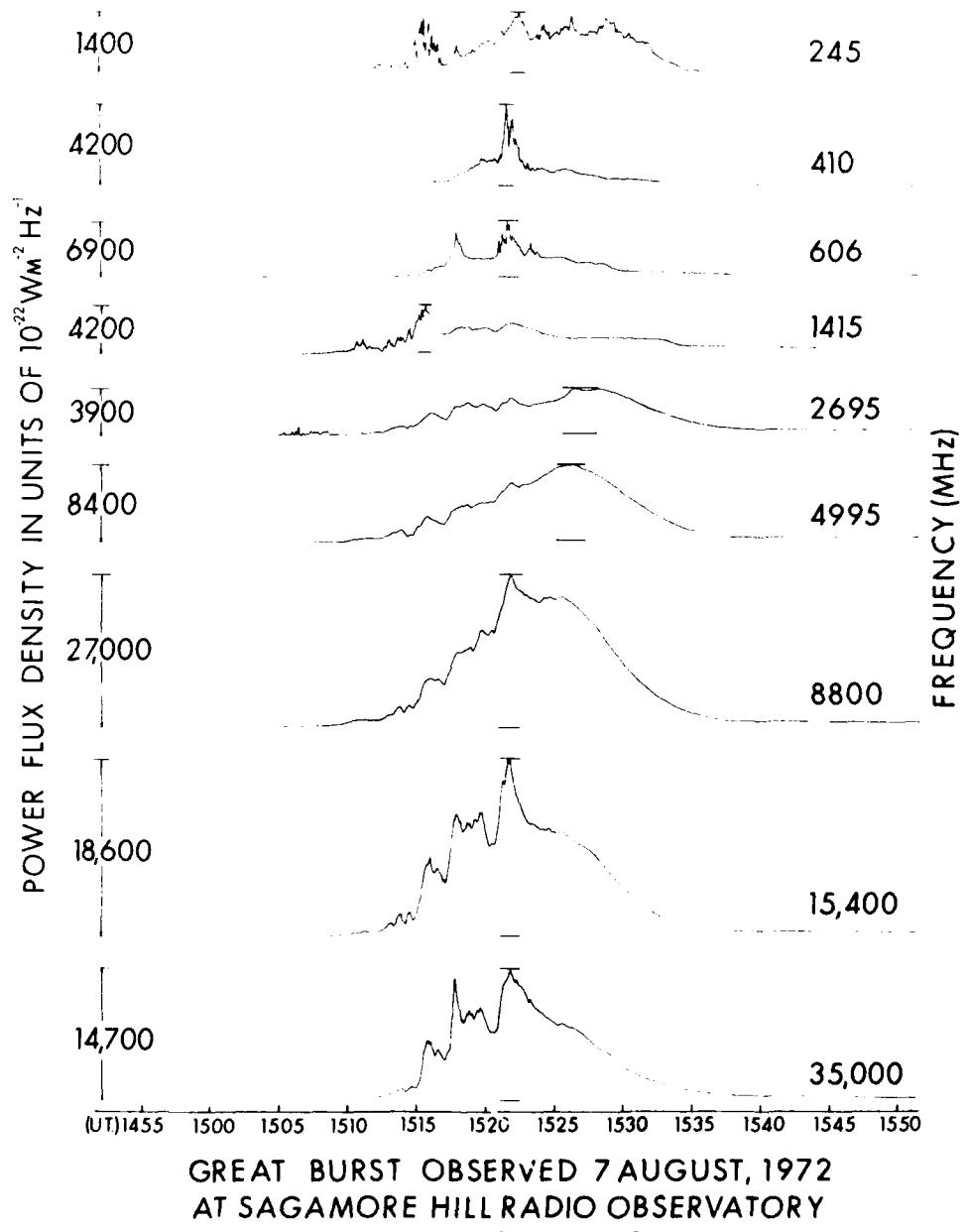




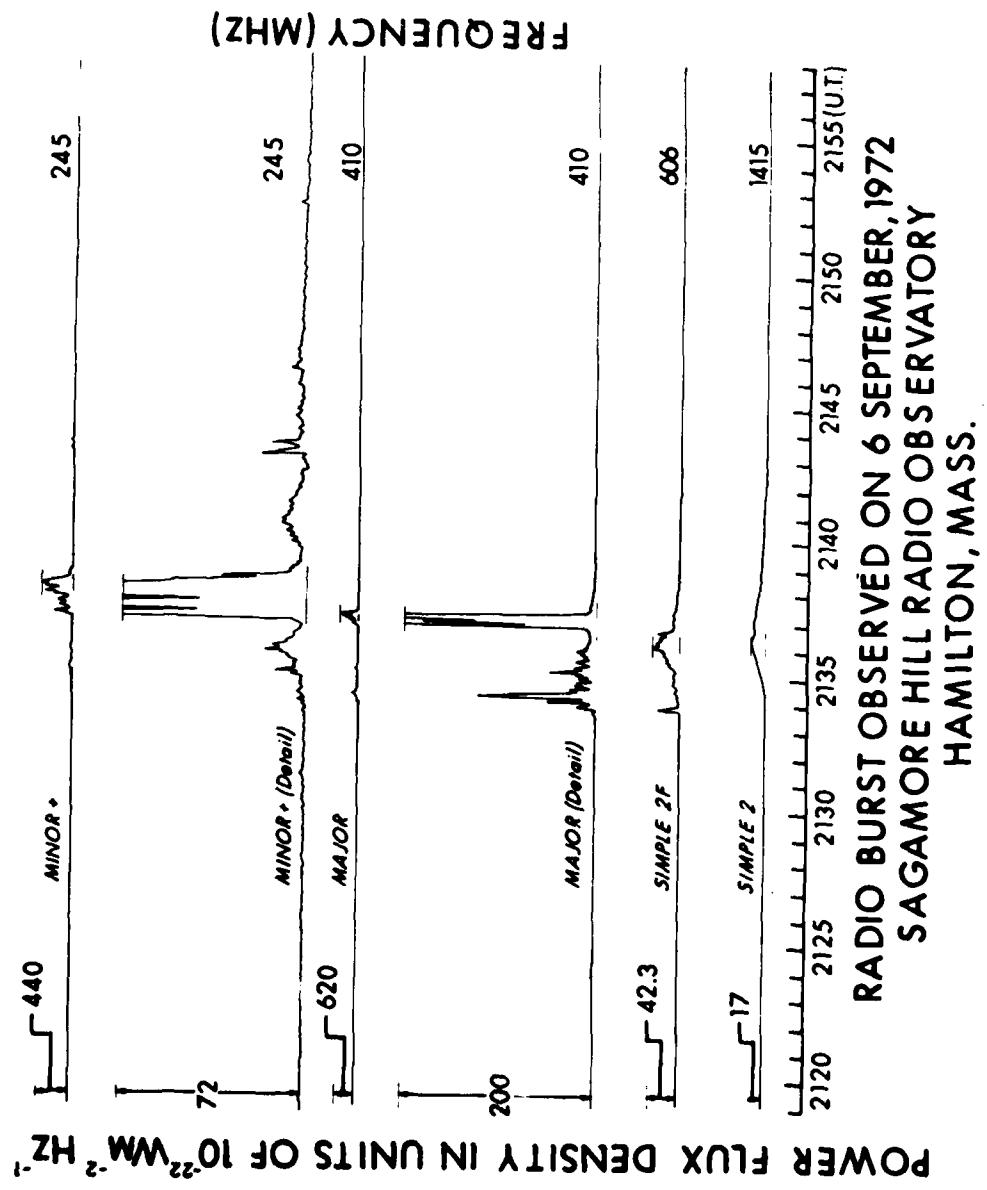
GREAT BURST OBSERVED 2 AUGUST 1972 AT SAGAMORE HILL RADIO
OBSERVATORY, HAMILTON, MASS.

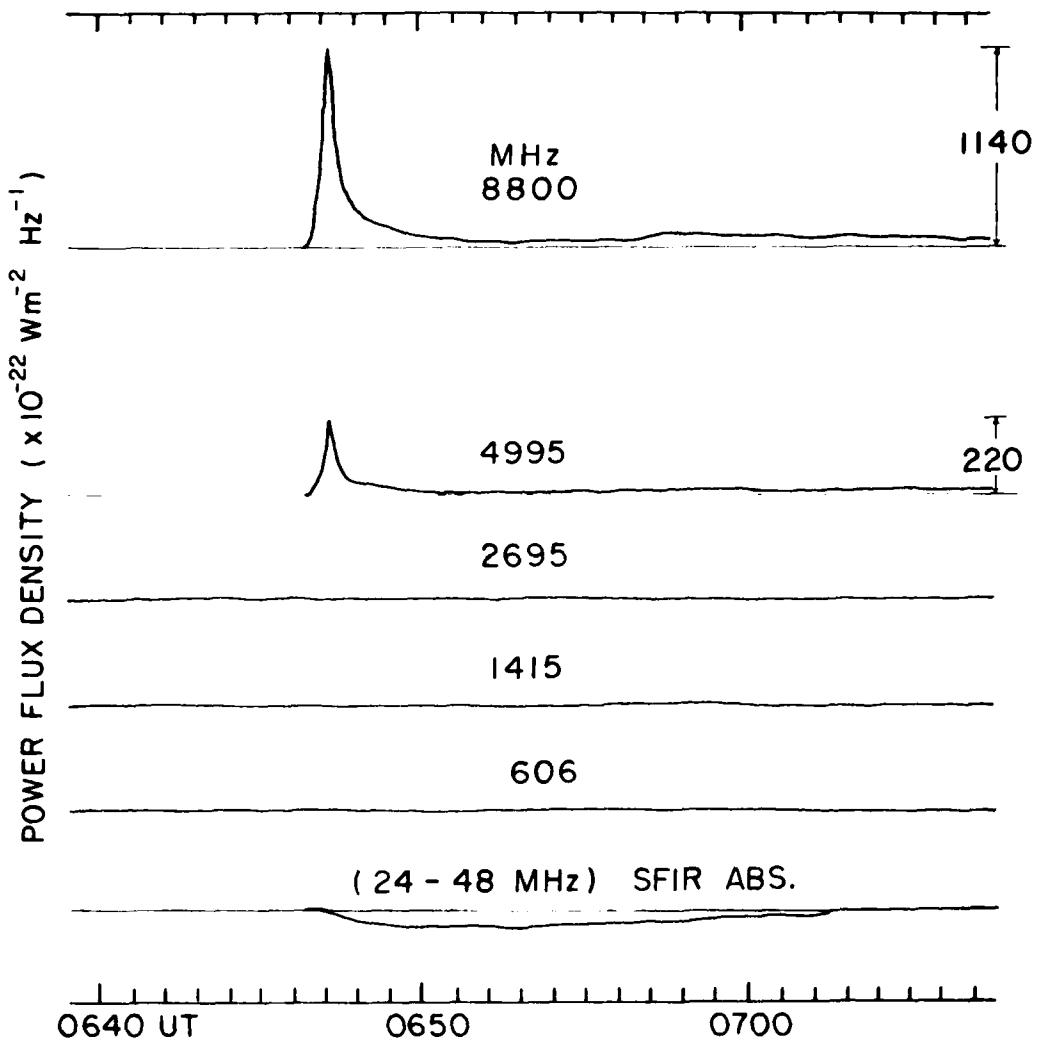


GREAT RADIO BURST OBSERVED ON 04 AUGUST 1972
AT MANILA OBSERVATORY, R.P.

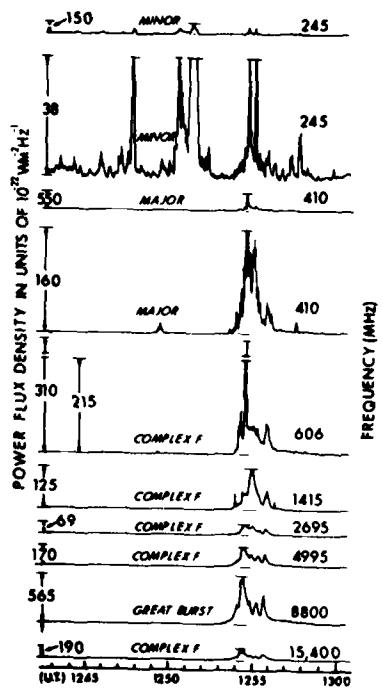


GREAT BURST OBSERVED 7 AUGUST, 1972
AT SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

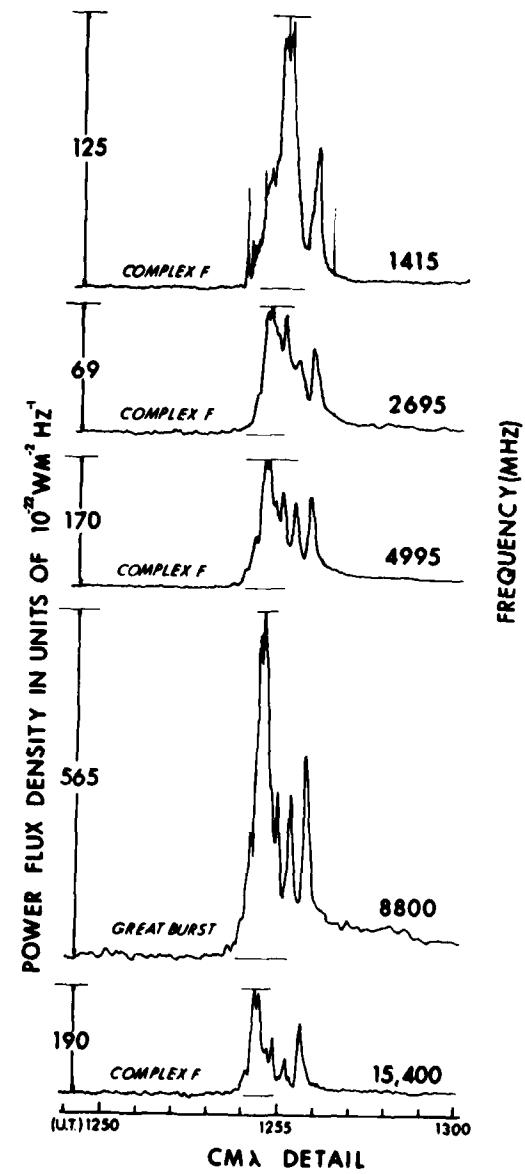


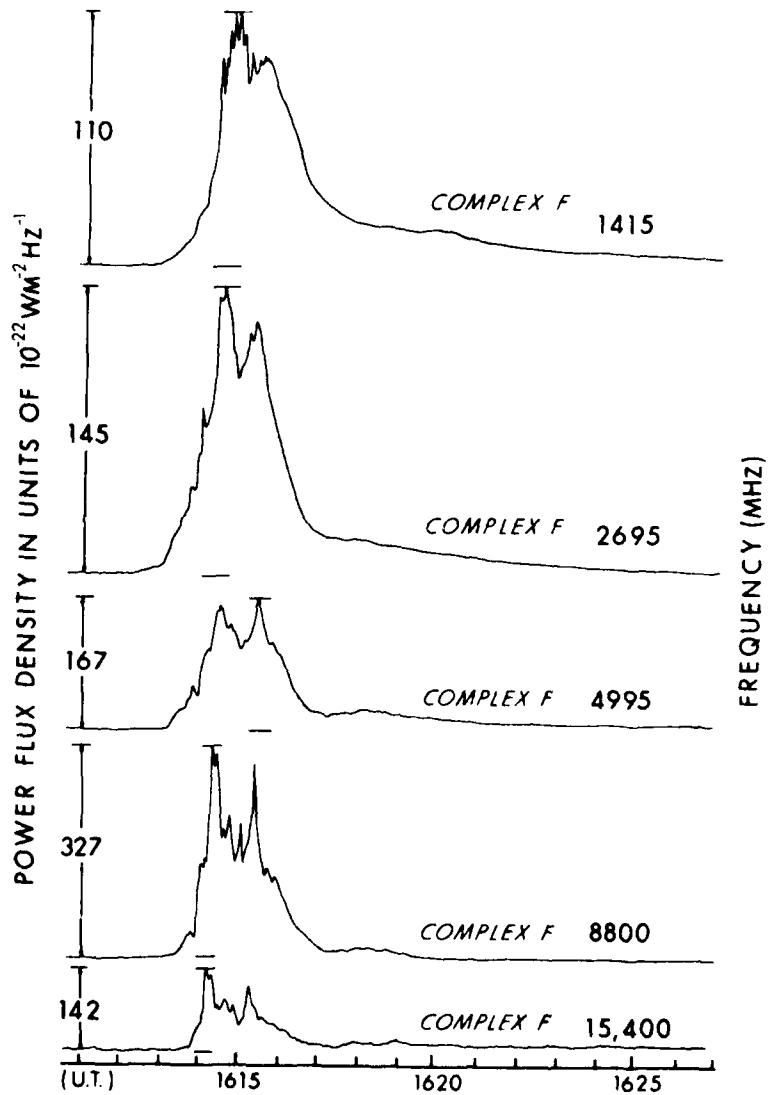


SIMPLE 2 & GREAT RADIO BURST OBSERVED ON
OCTOBER 26, 1972 AT MANILA OBSERVATORY, R.P.

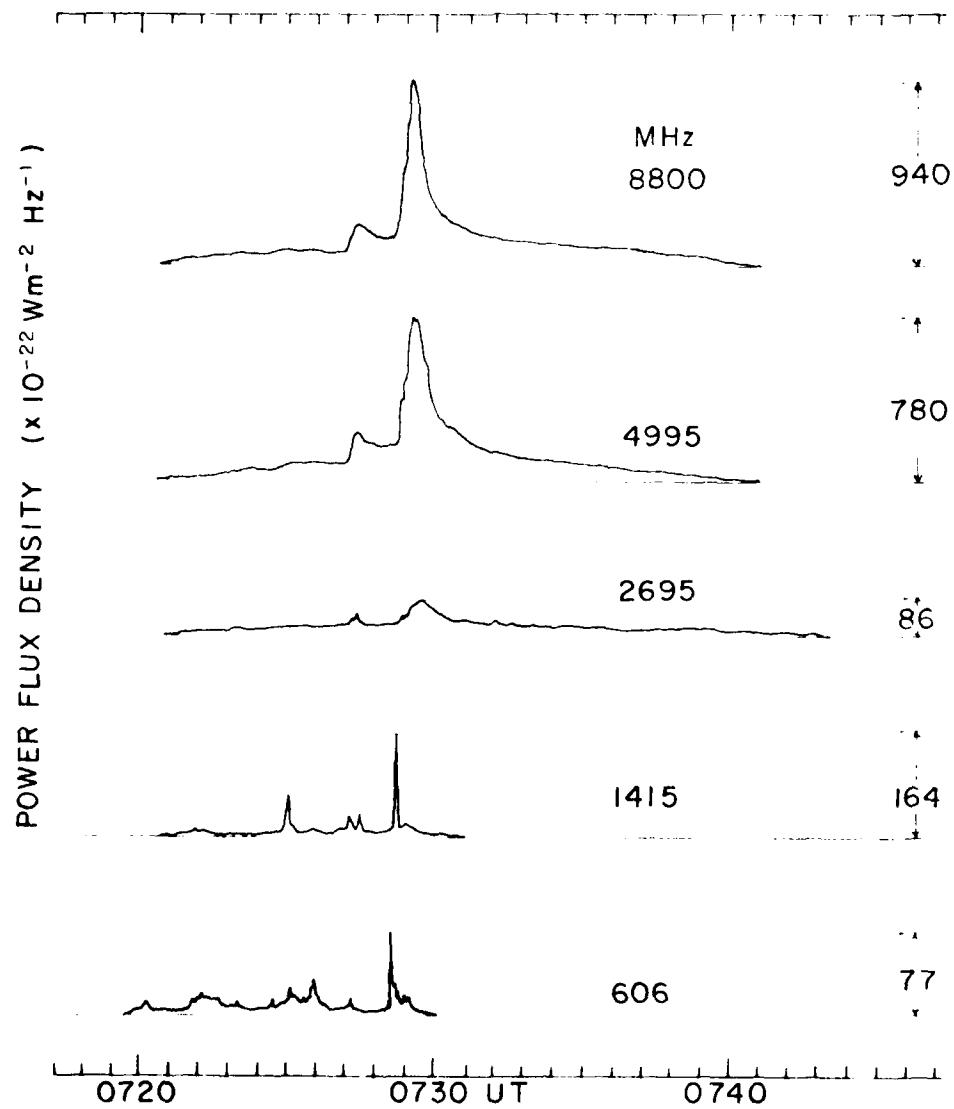


SOLAR RADIO BURST
OBSERVED 26 OCTOBER, 1972
AT SAGAMORE HILL
RADIO OBSERVATORY
HAMMOND, MASS.

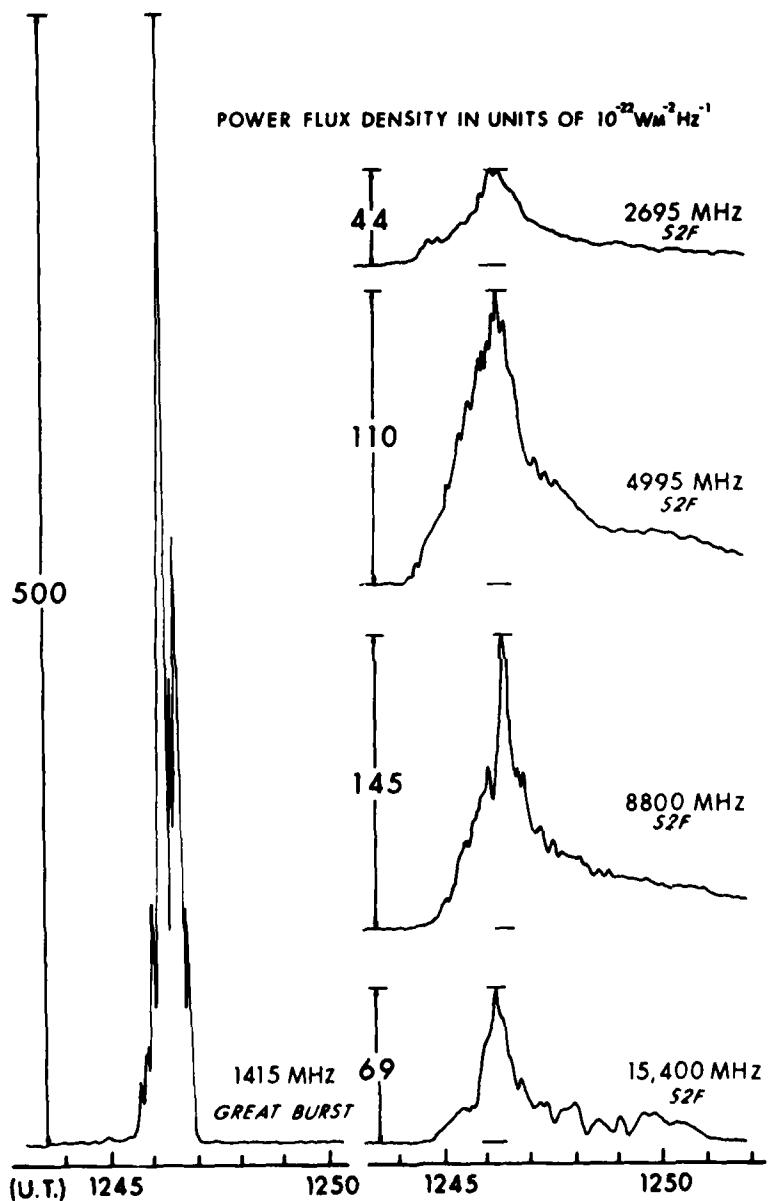




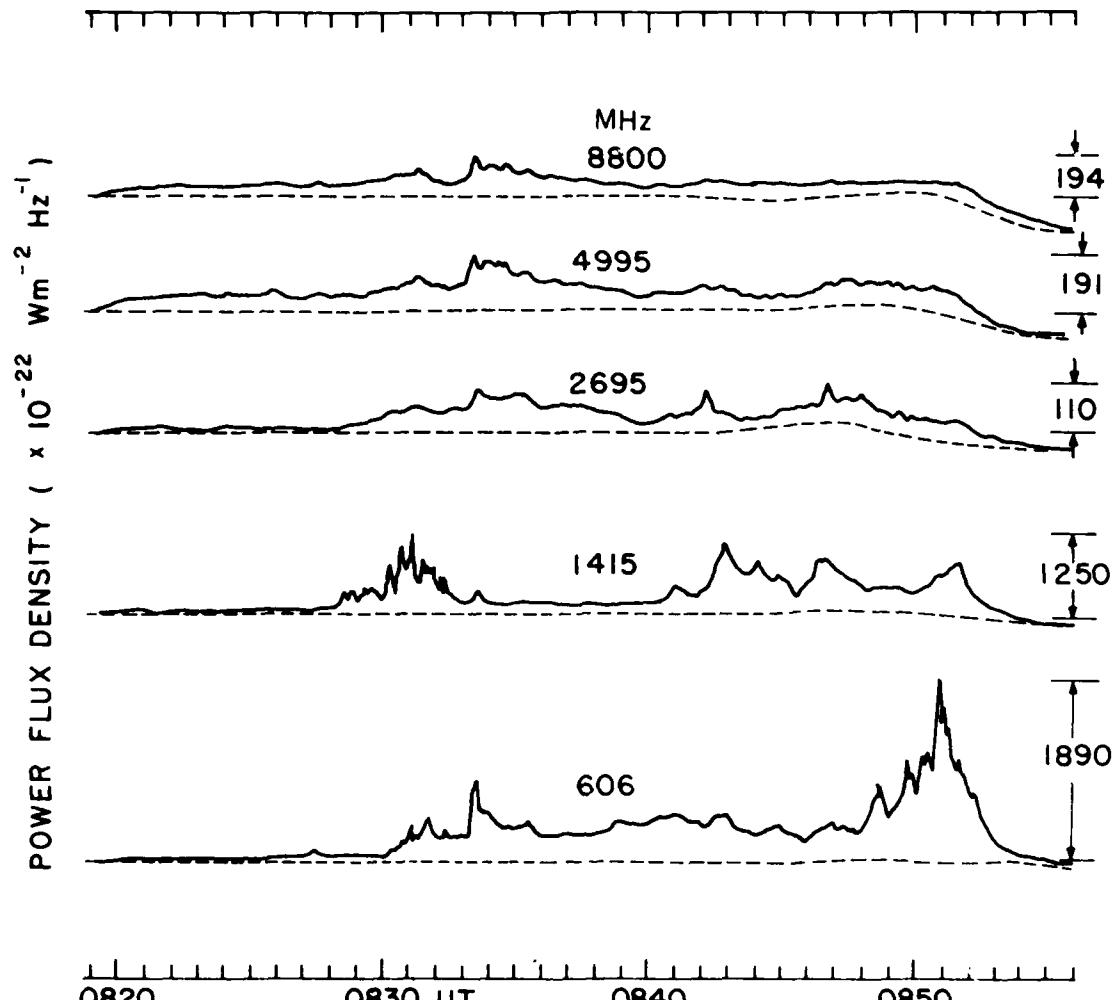
CΜΑ RADIO BURST OBSERVED ON 29 OCTOBER, 1972
 SAGAMORE HILL RADIO OBSERVATORY
 HAMILTON, MASS.



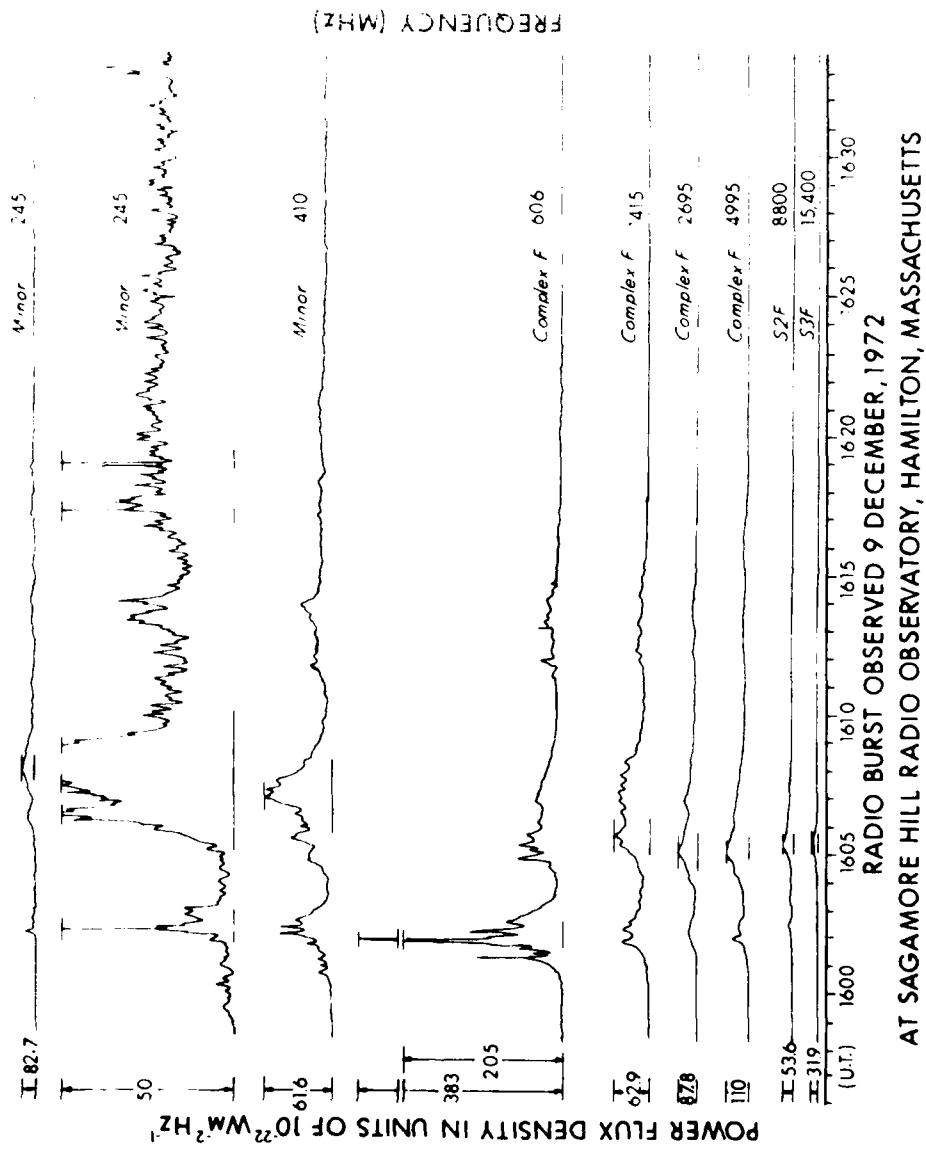
SIMPLE 2F & GREAT RADIO BURST OBSERVED ON
OCTOBER 30, 1972 AT MANILA OBSERVATORY, R.P.

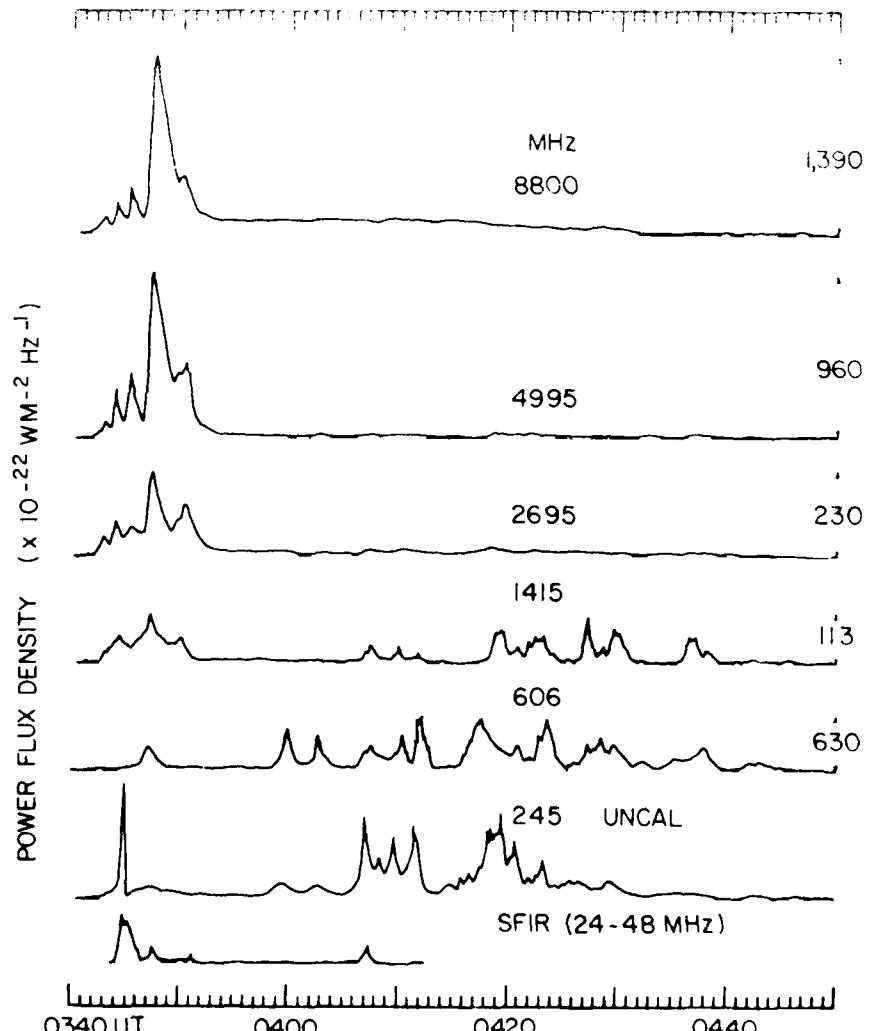


RADIO BURST OBSERVED ON 3 NOVEMBER, 1972
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



SIMPLE 2F & GREAT RADIO BURST OBSERVED ON 25
NOVEMBER 1972 AT MANILA OBSERVATORY, R. P.
---- BROKEN LINES ARE QUIET SUN SUNSET CURVES

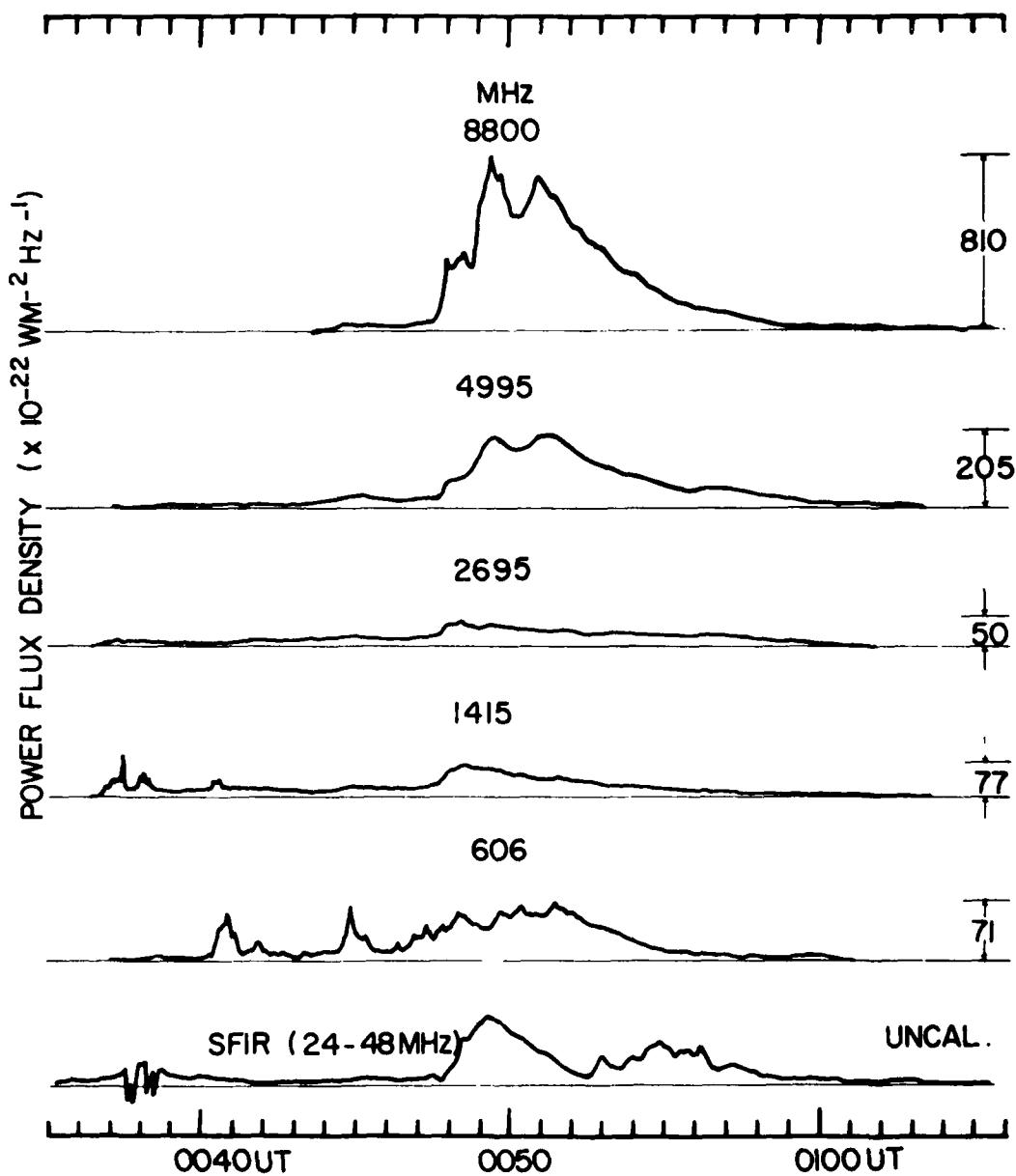




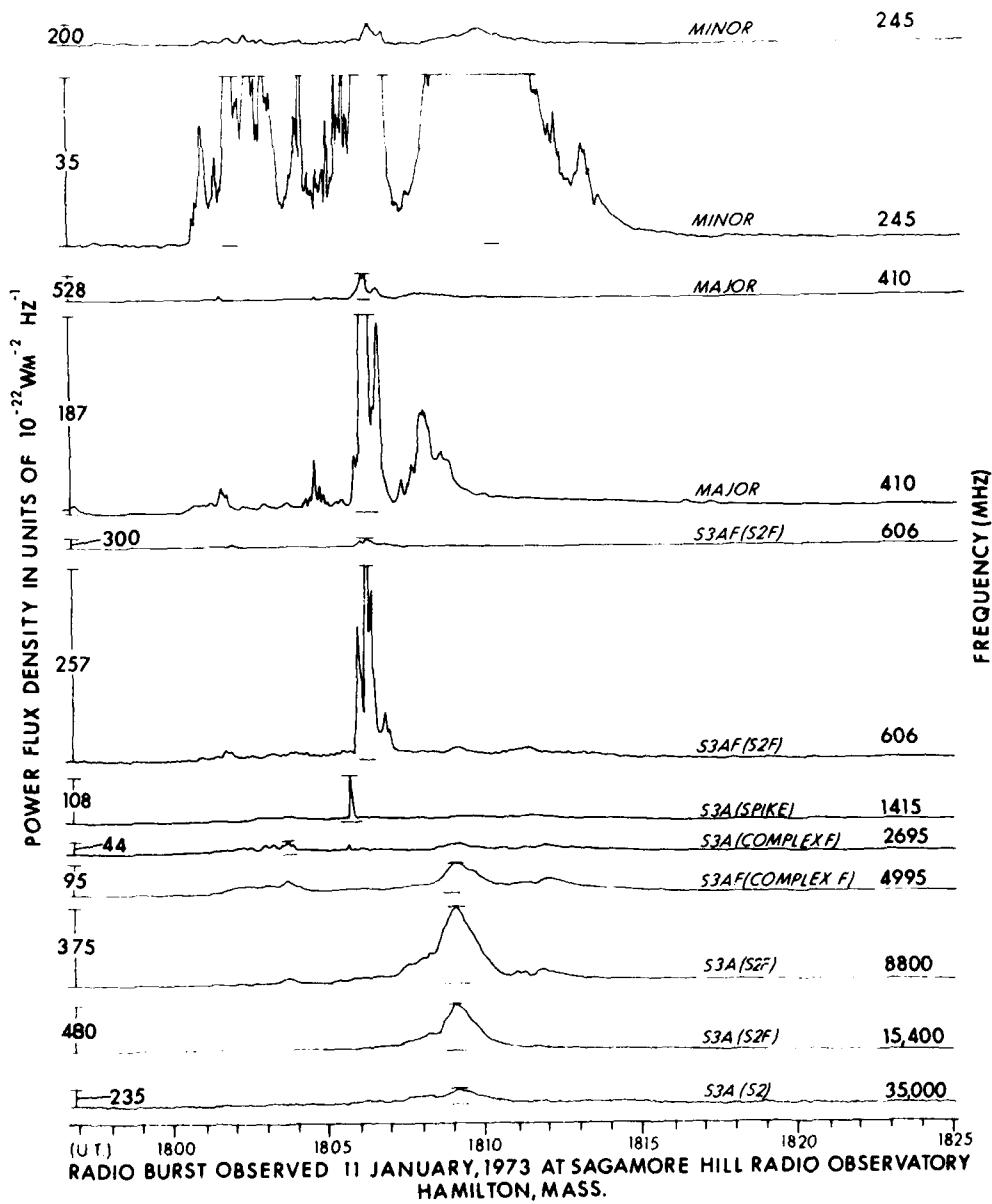
GREAT RADIO BURST OBSERVED ON DECEMBER 16, 1972
AT THE MANILA OBSERVATORY, R P

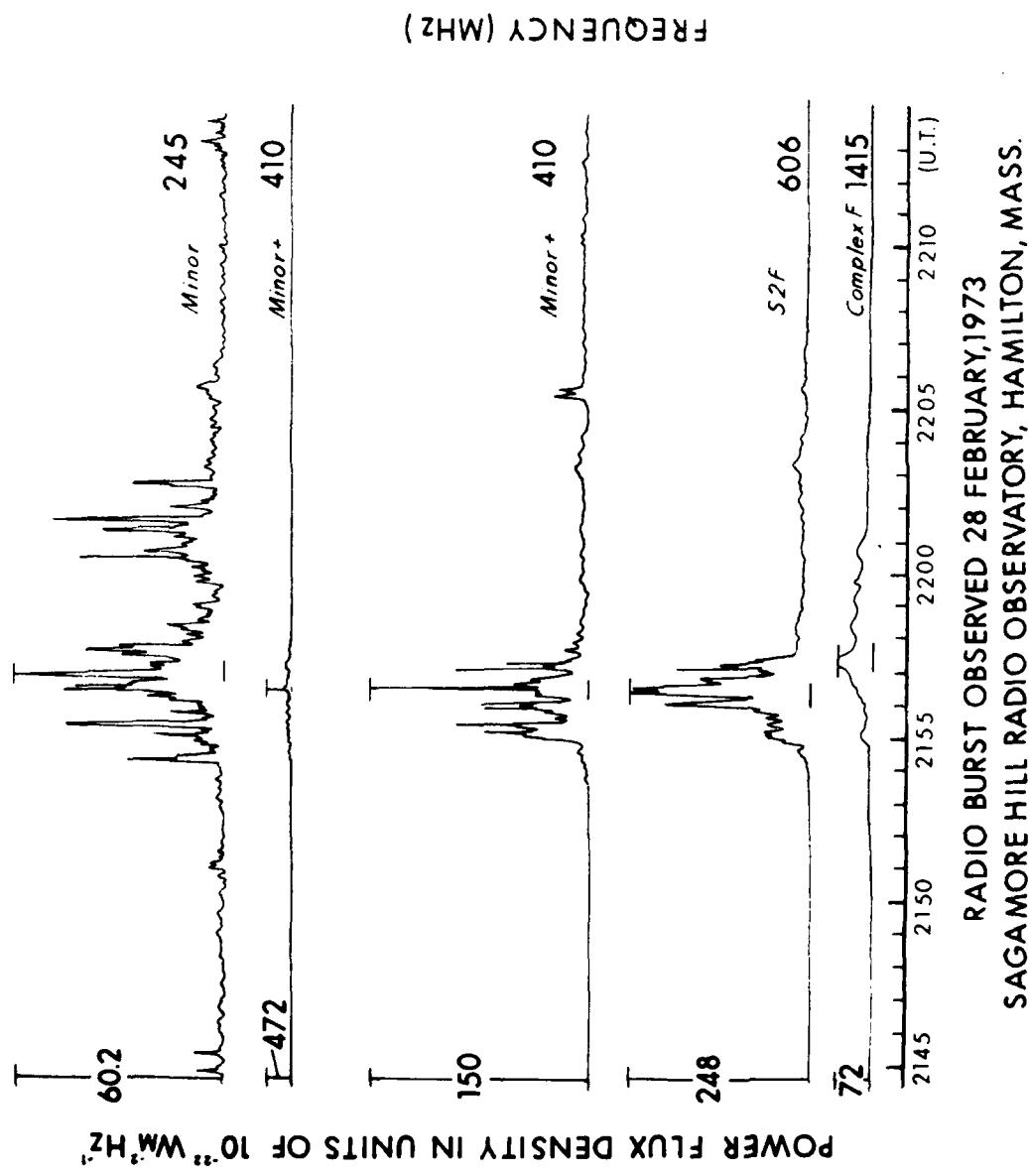
SEARCHING PAGE BLANK-NOT FILMED

**Solar Radio Bursts
1973**

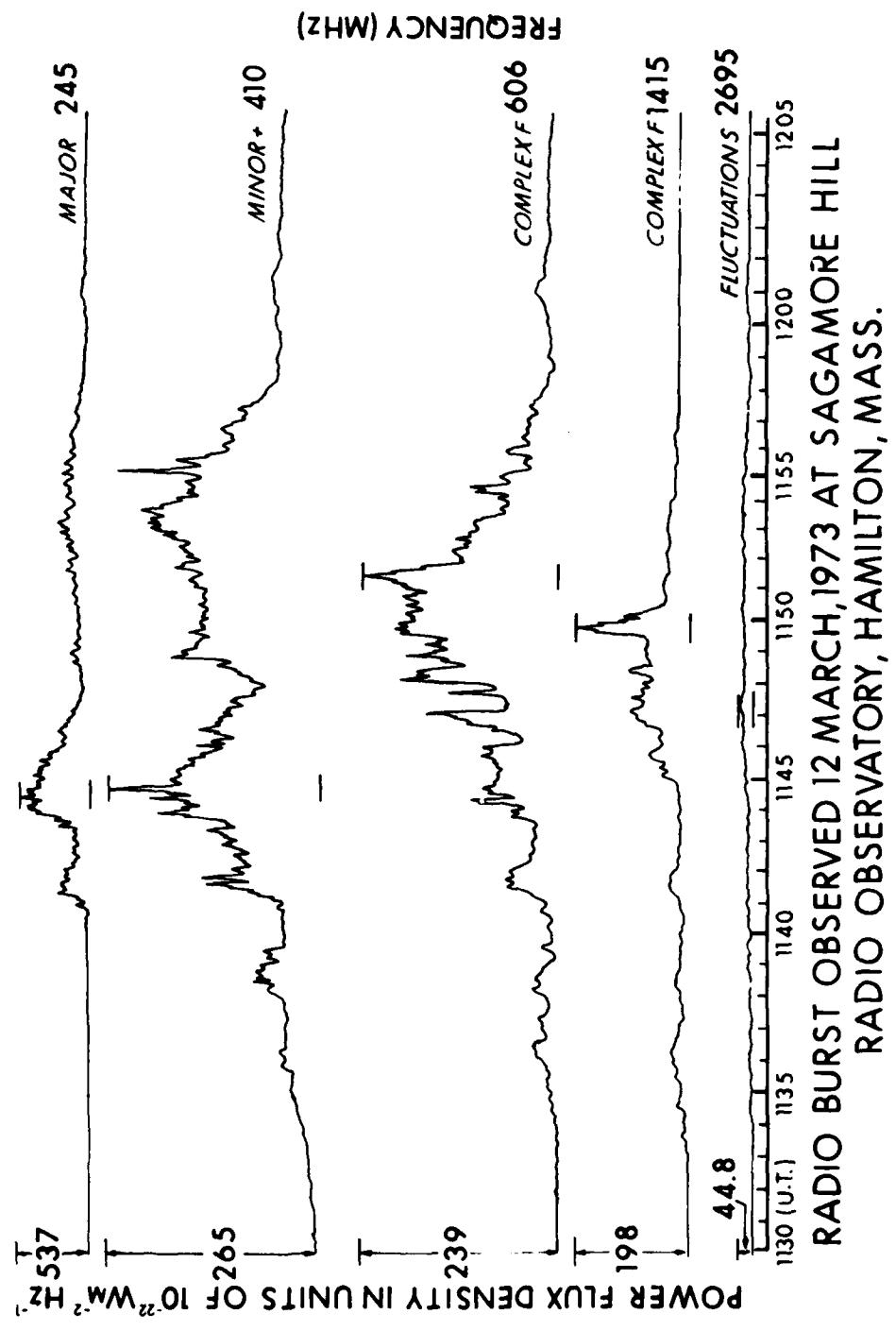


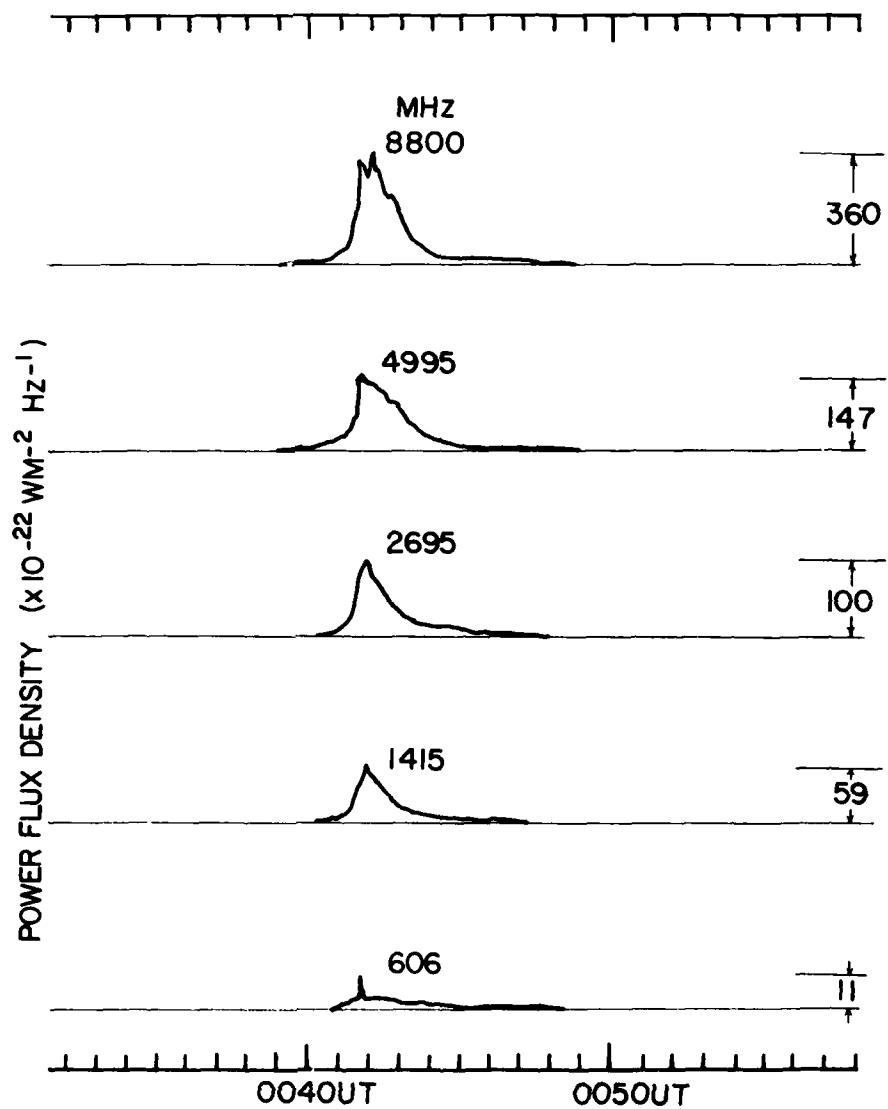
COMPLEX F & GREAT RADIO BURST OBSERVED ON
JANUARY 11, 1973 AT MANILA OBSERVATORY, R.P.



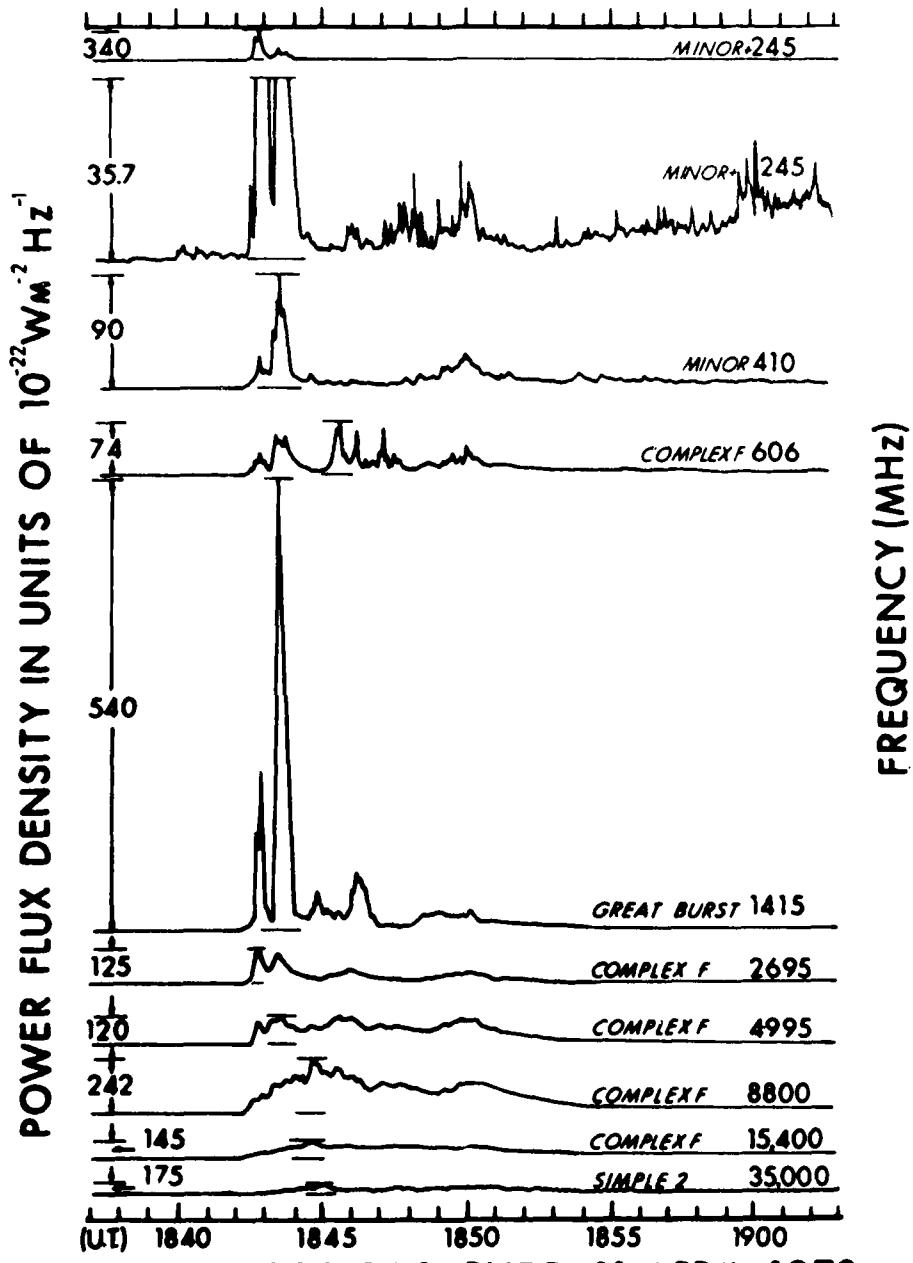


RADIO BURST OBSERVED 28 FEBRUARY, 1973
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

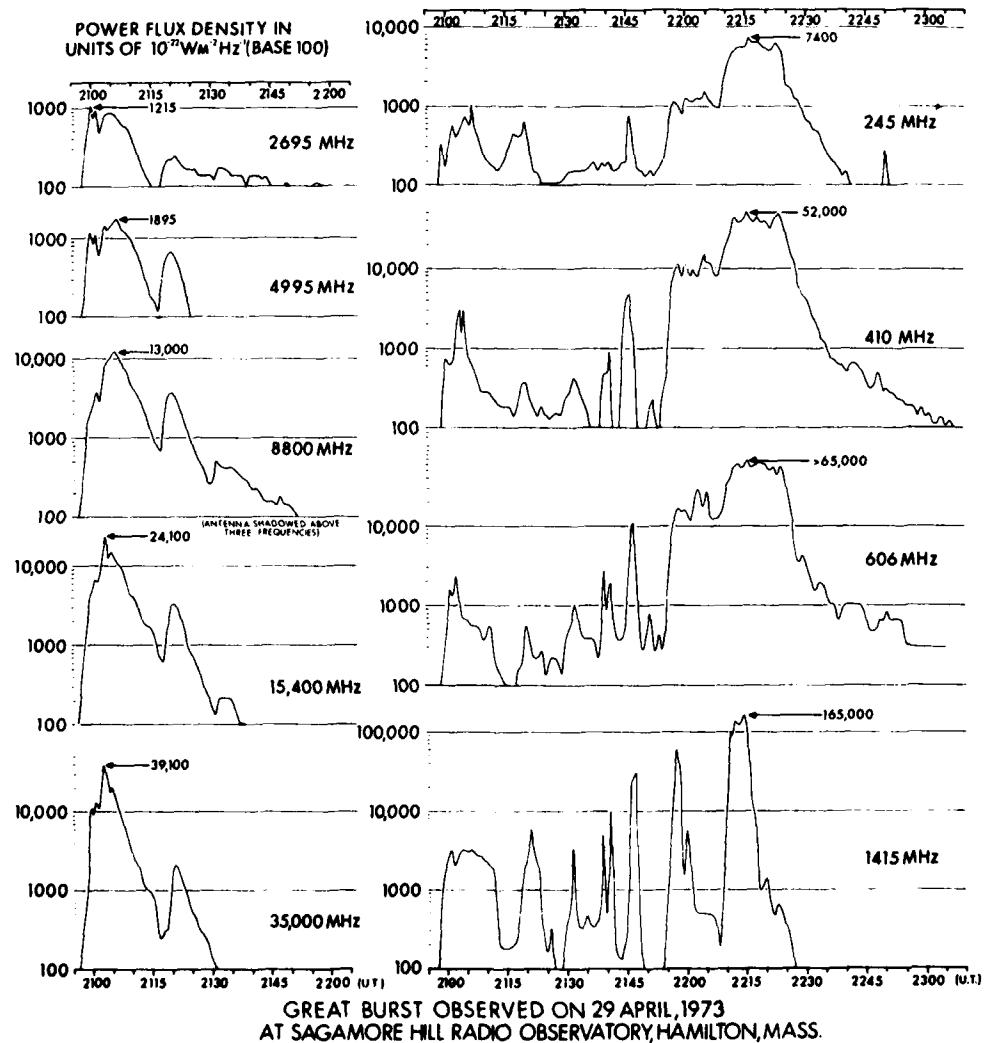


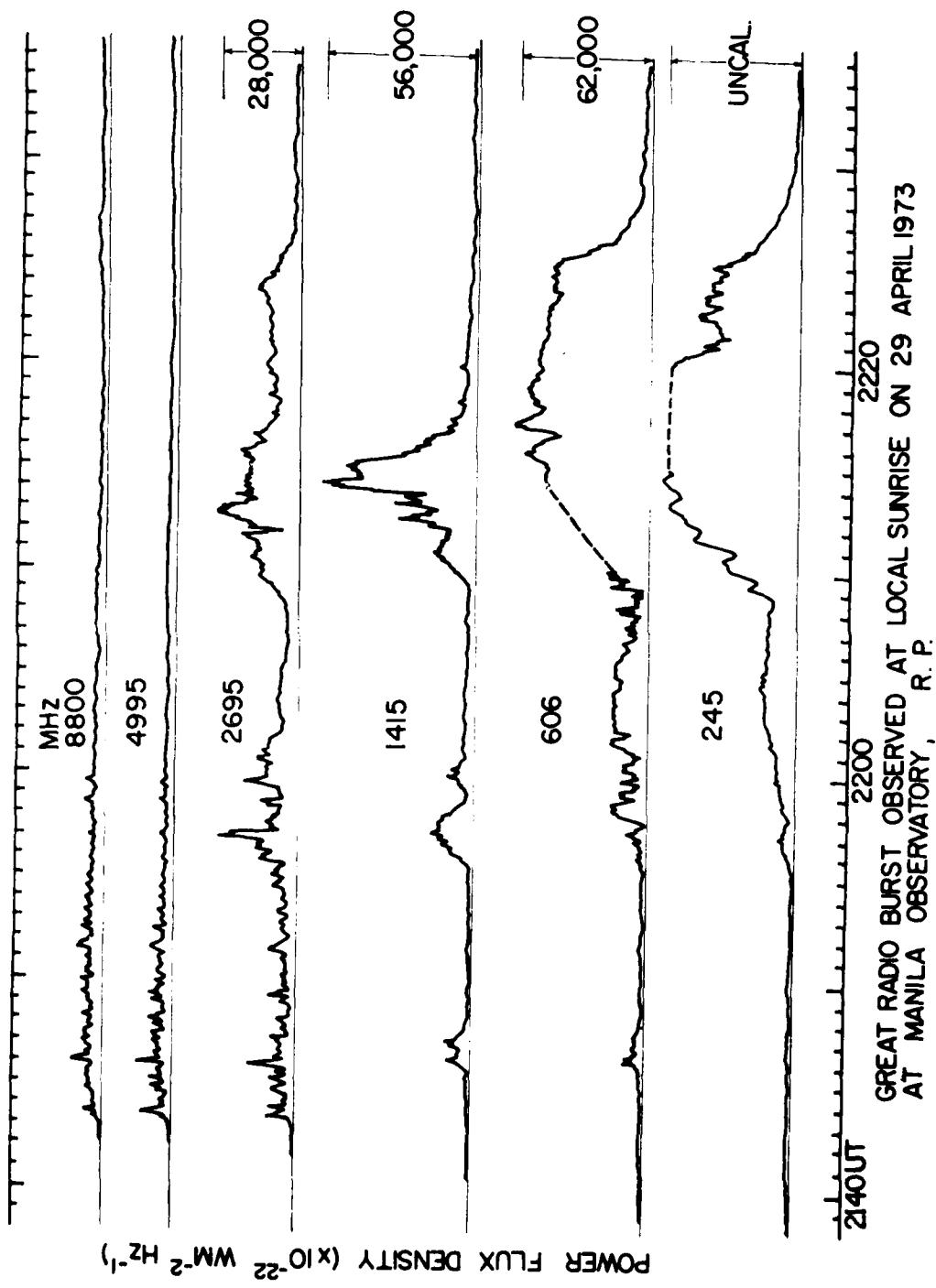


SIMPLE 2F RADIO BURST OBSERVED ON 25 MARCH
1973 AT MANILA OBSERVATORY, R. P.

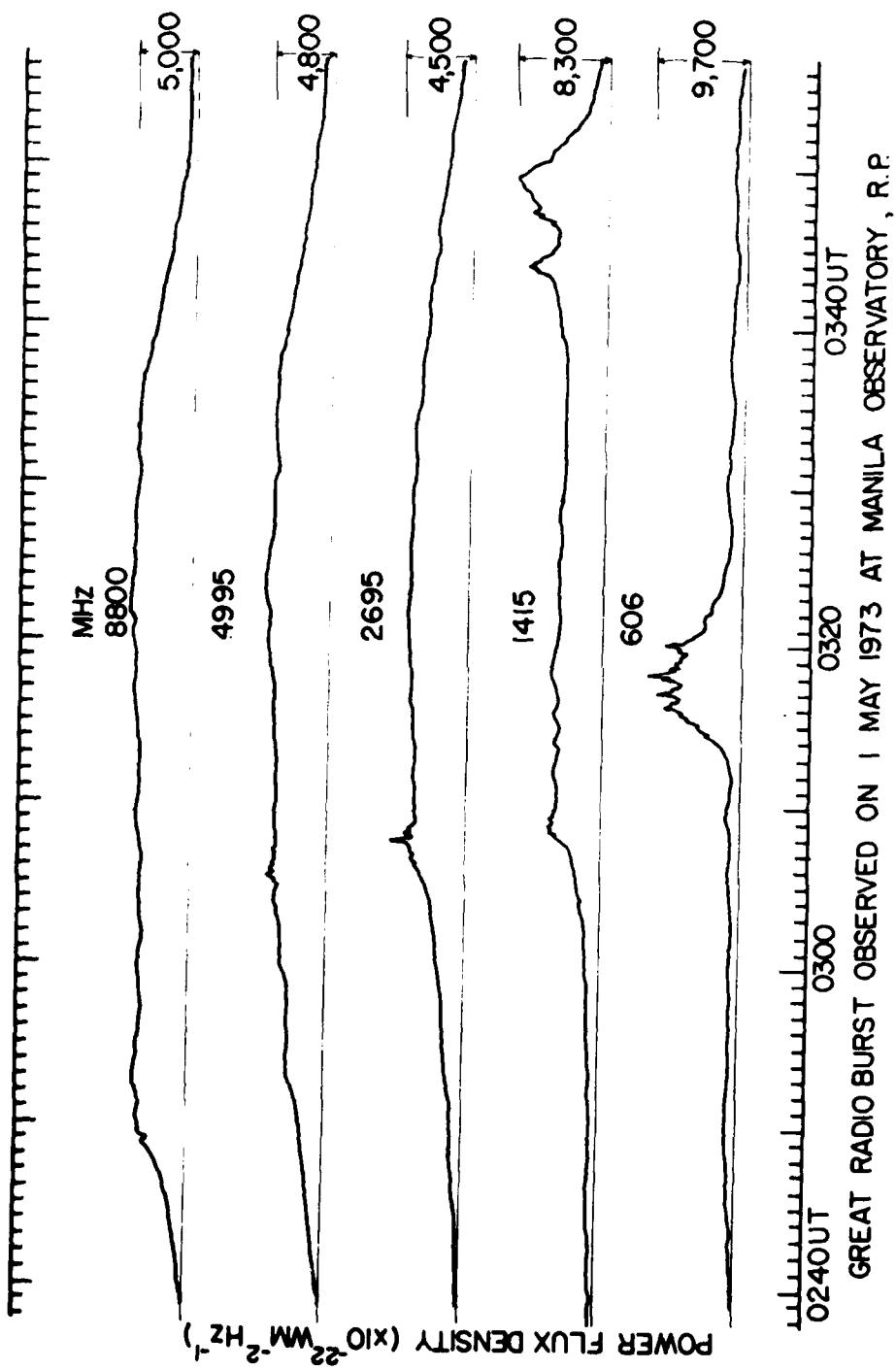


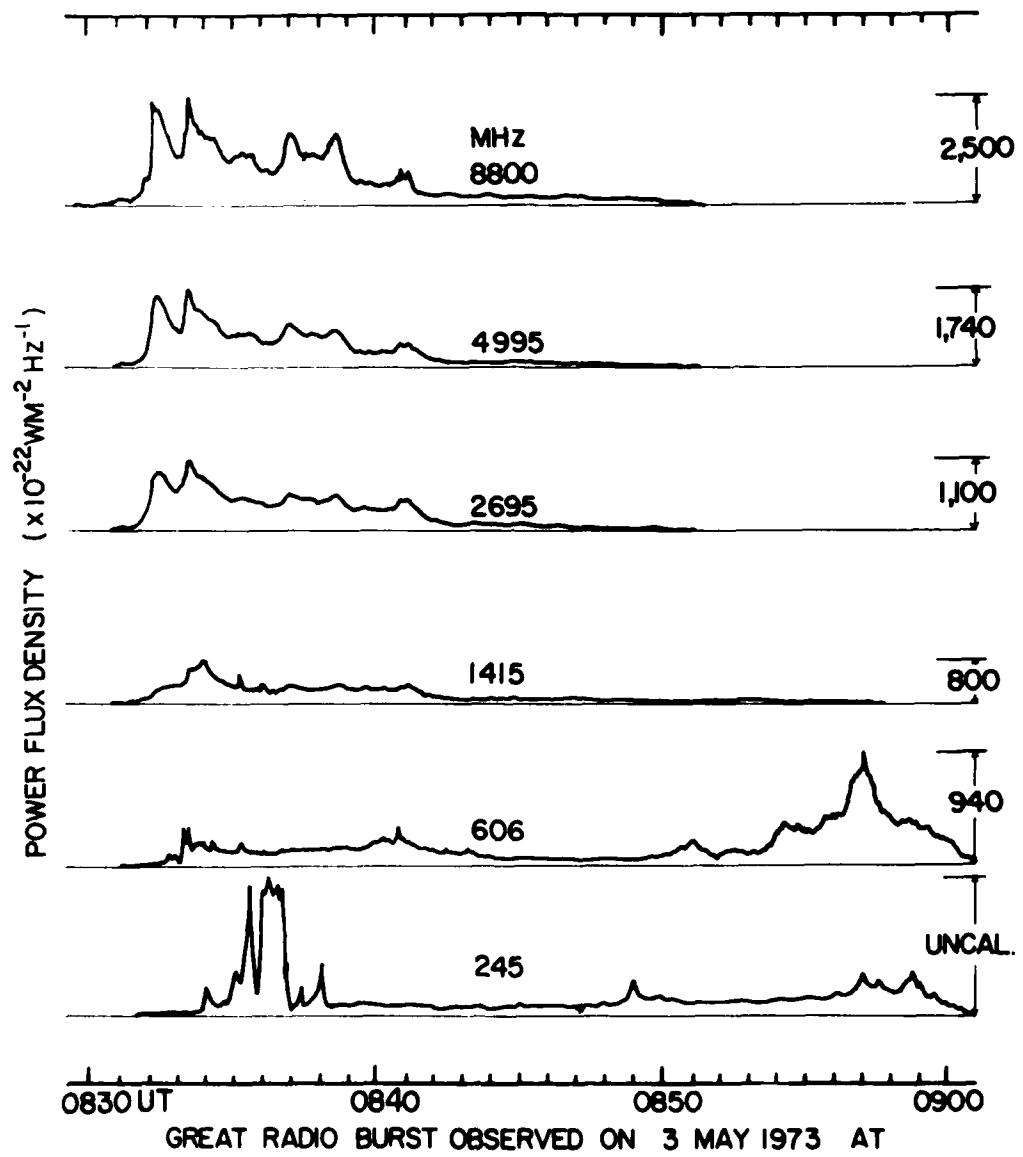
RADIO BURST OBSERVED 11 APRIL, 1973
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.

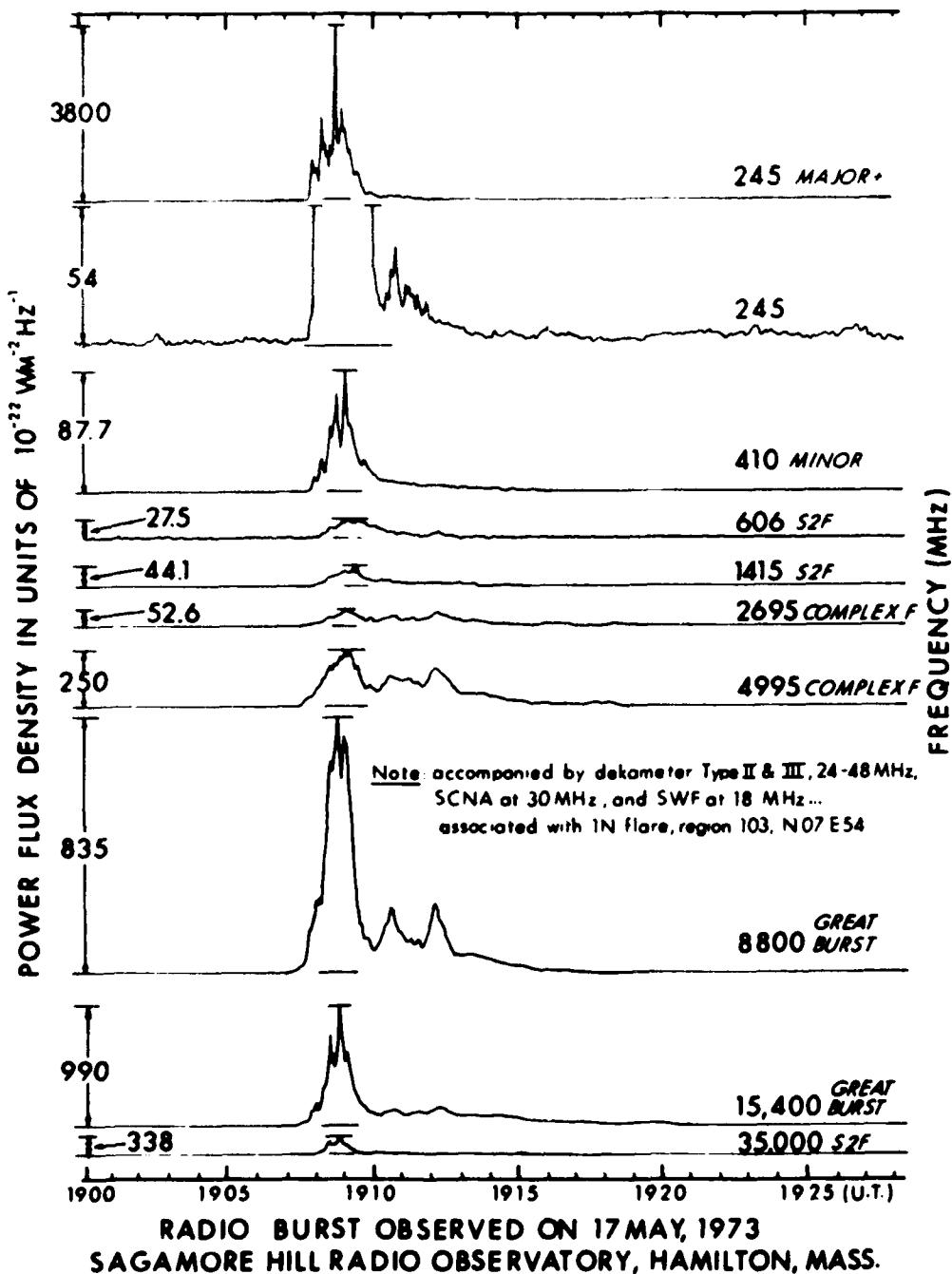


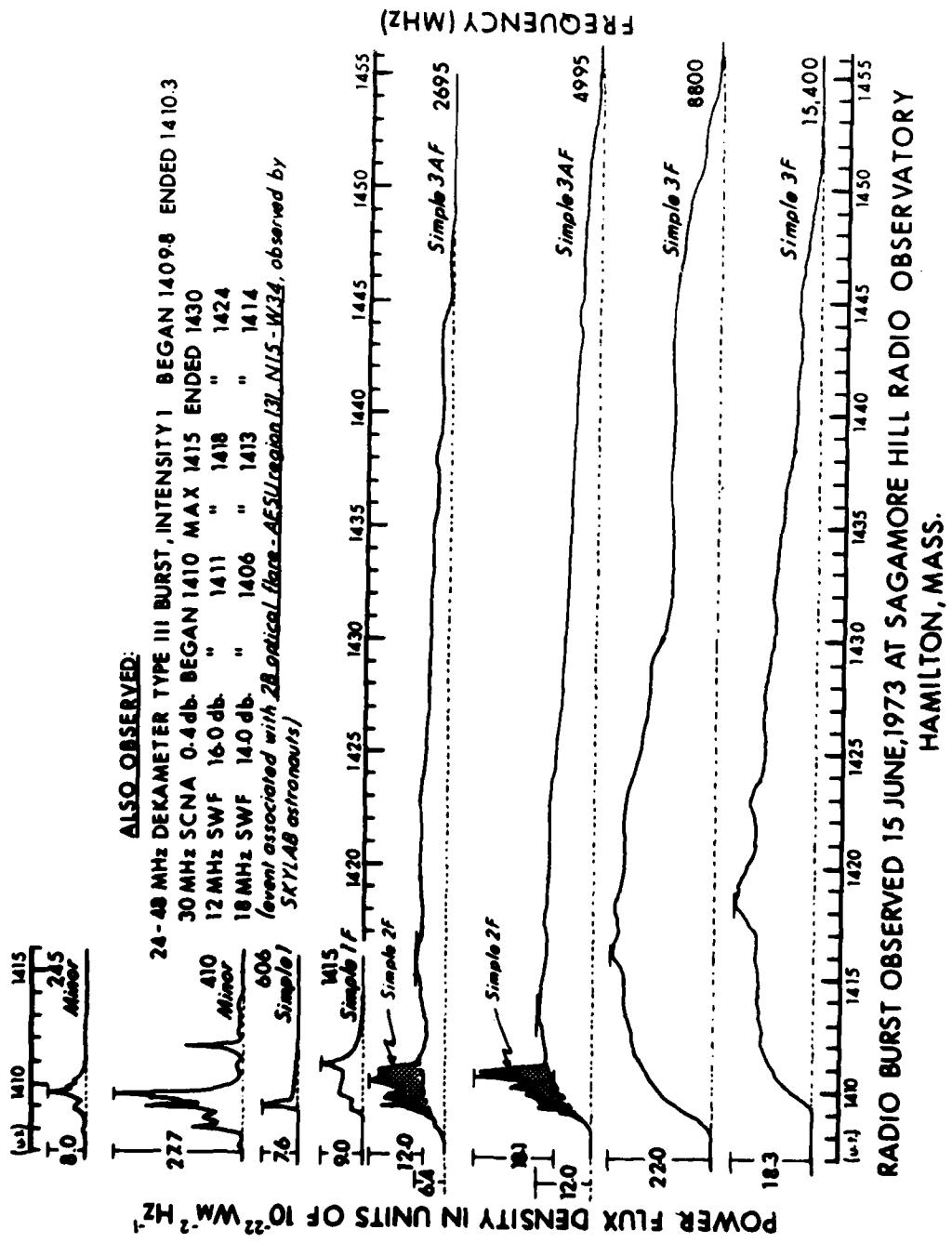


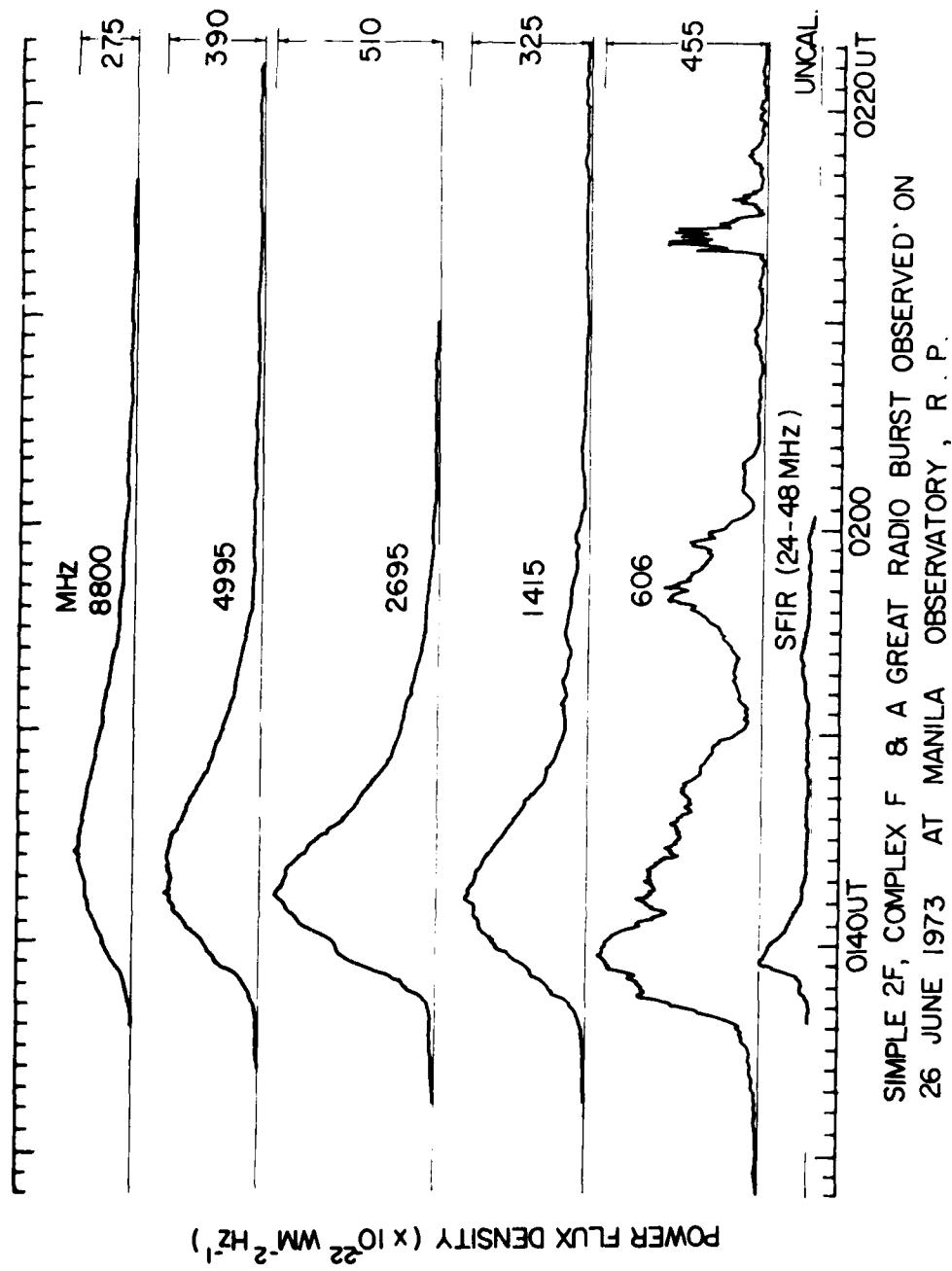
GREAT RADIO BURST OBSERVED AT LOCAL SUNRISE ON 29 APRIL 1973
AT MANILA OBSERVATORY, R. P.









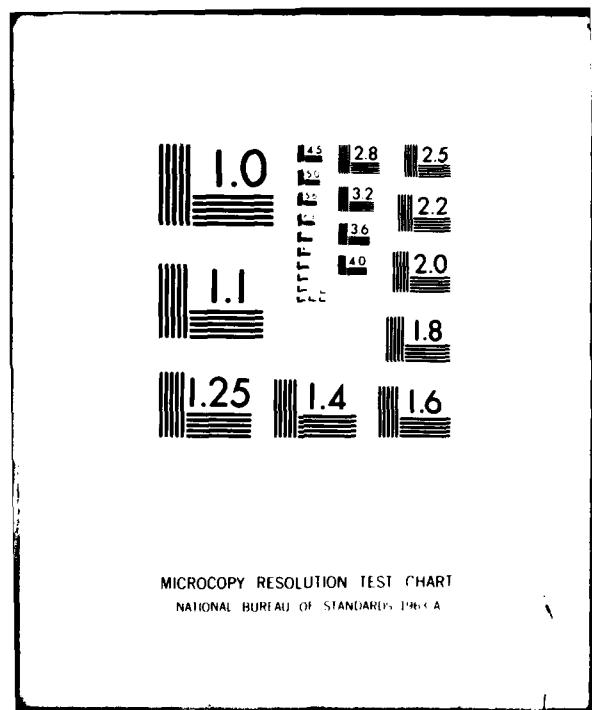


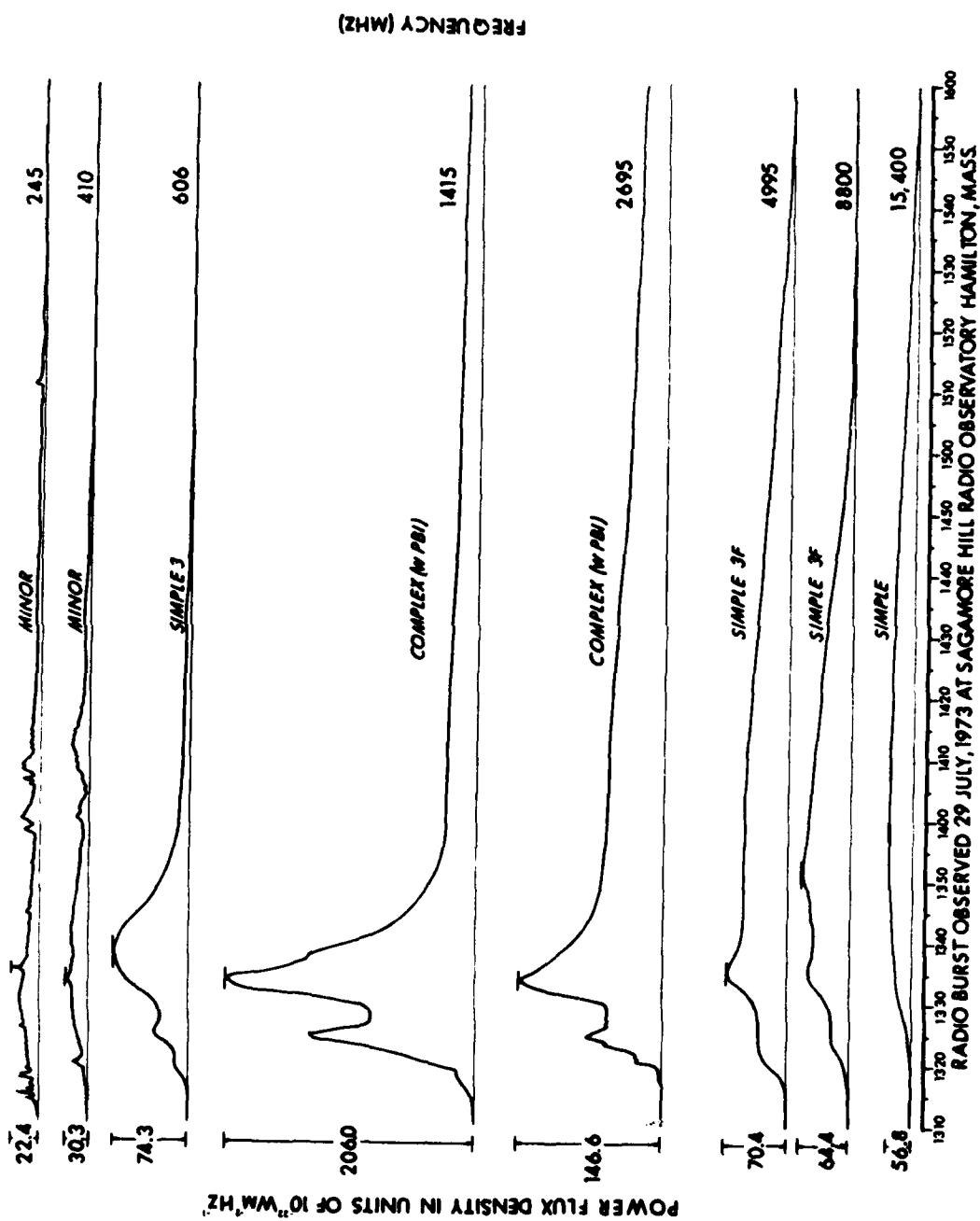
SIMPLE 2F, COMPLEX F & A GREAT RADIO BURST OBSERVED ON
26 JUNE 1973 AT MANILA OBSERVATORY, R. P.

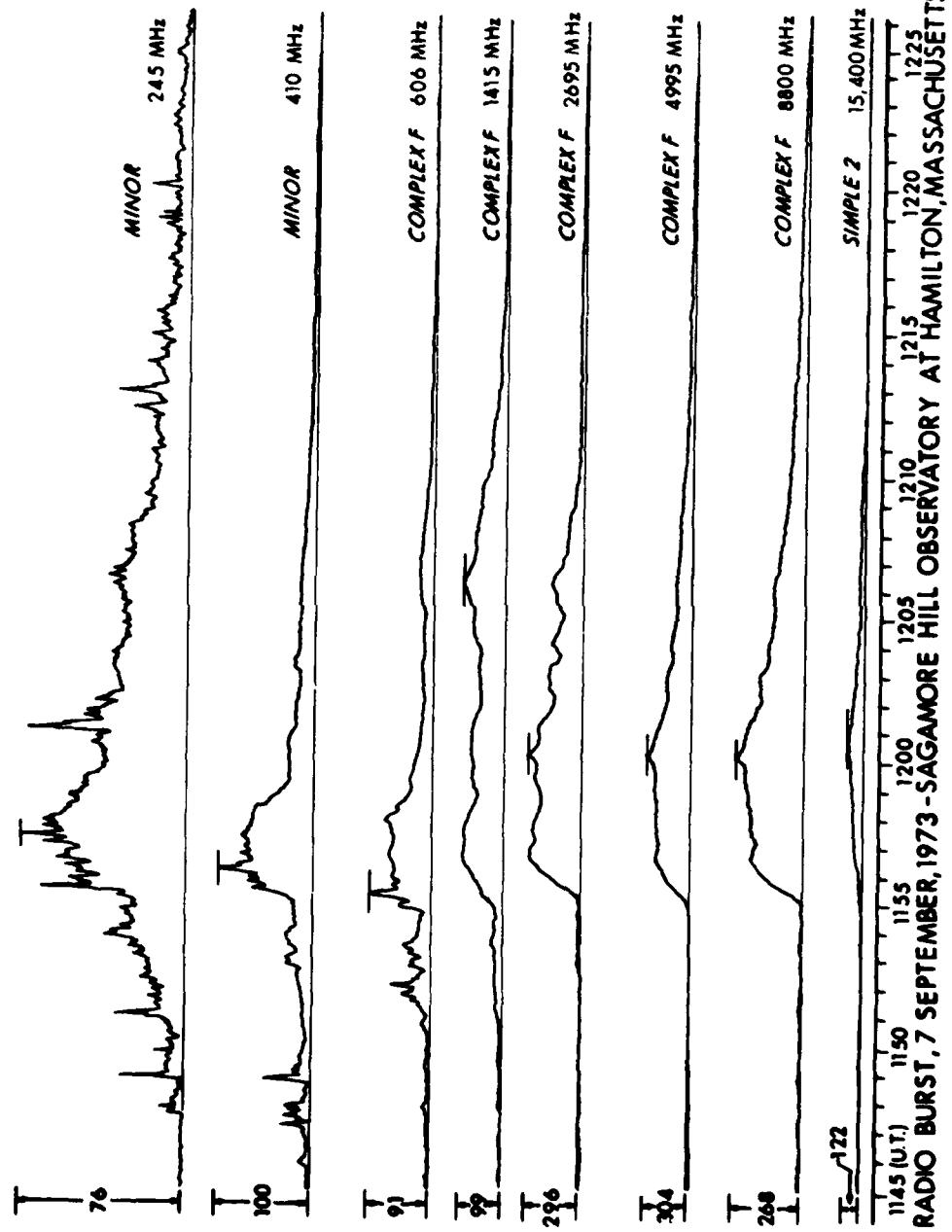
AD-A088 220 AIR FORCE GEOPHYSICS LAB HANSCOM AFB MA F/0 3/2
AN ATLAS OF SELECTED MULTI-FREQUENCY RADIO BURSTS FROM THE TWEN--ETC(U)
APR 80 W R BARRON, V L BADILLO, E W CLIVER
UNCLASSIFIED AFGL-TR-80-0098 NL

3x3

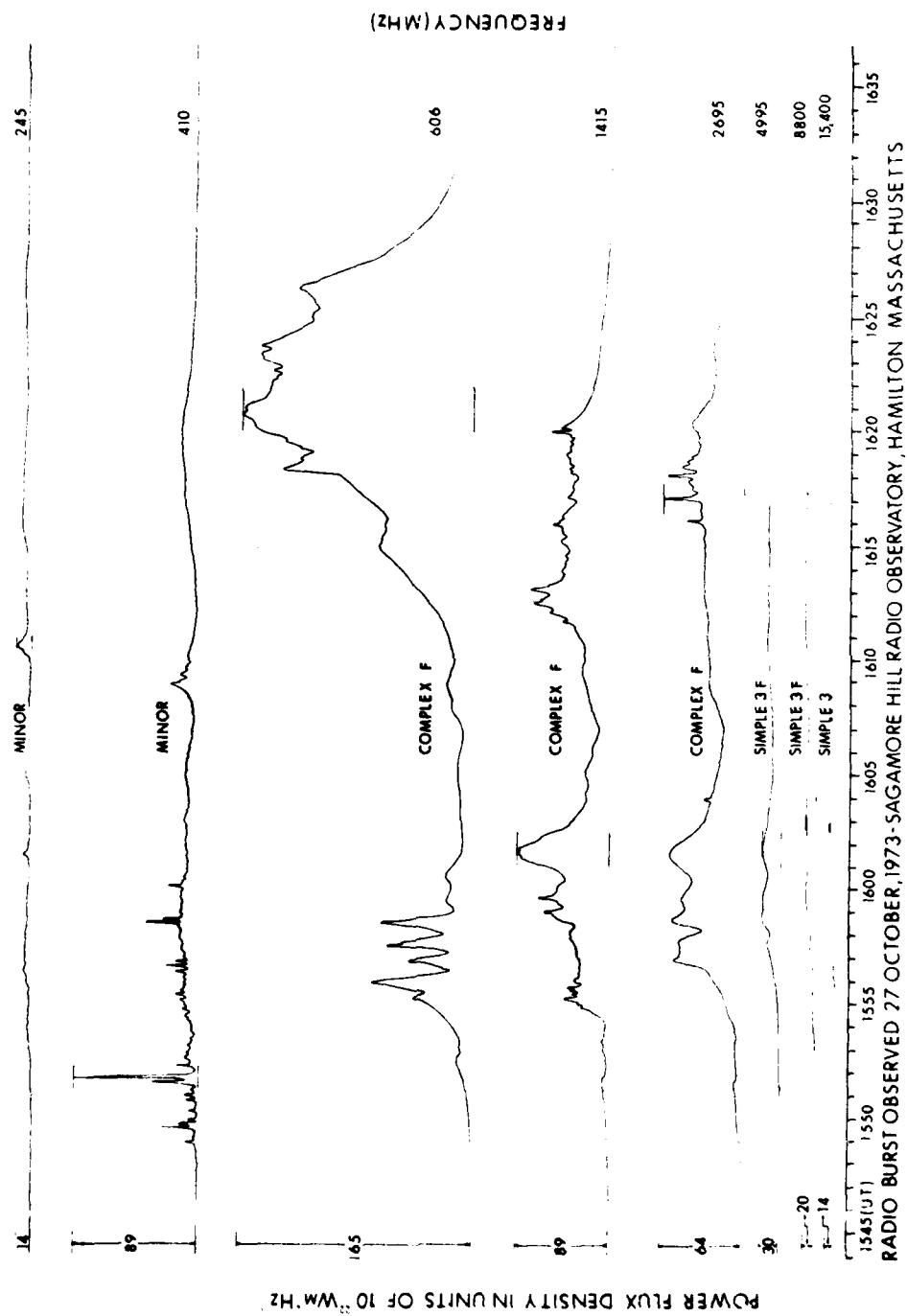
END
DATE
FILED
9-80
DTIC

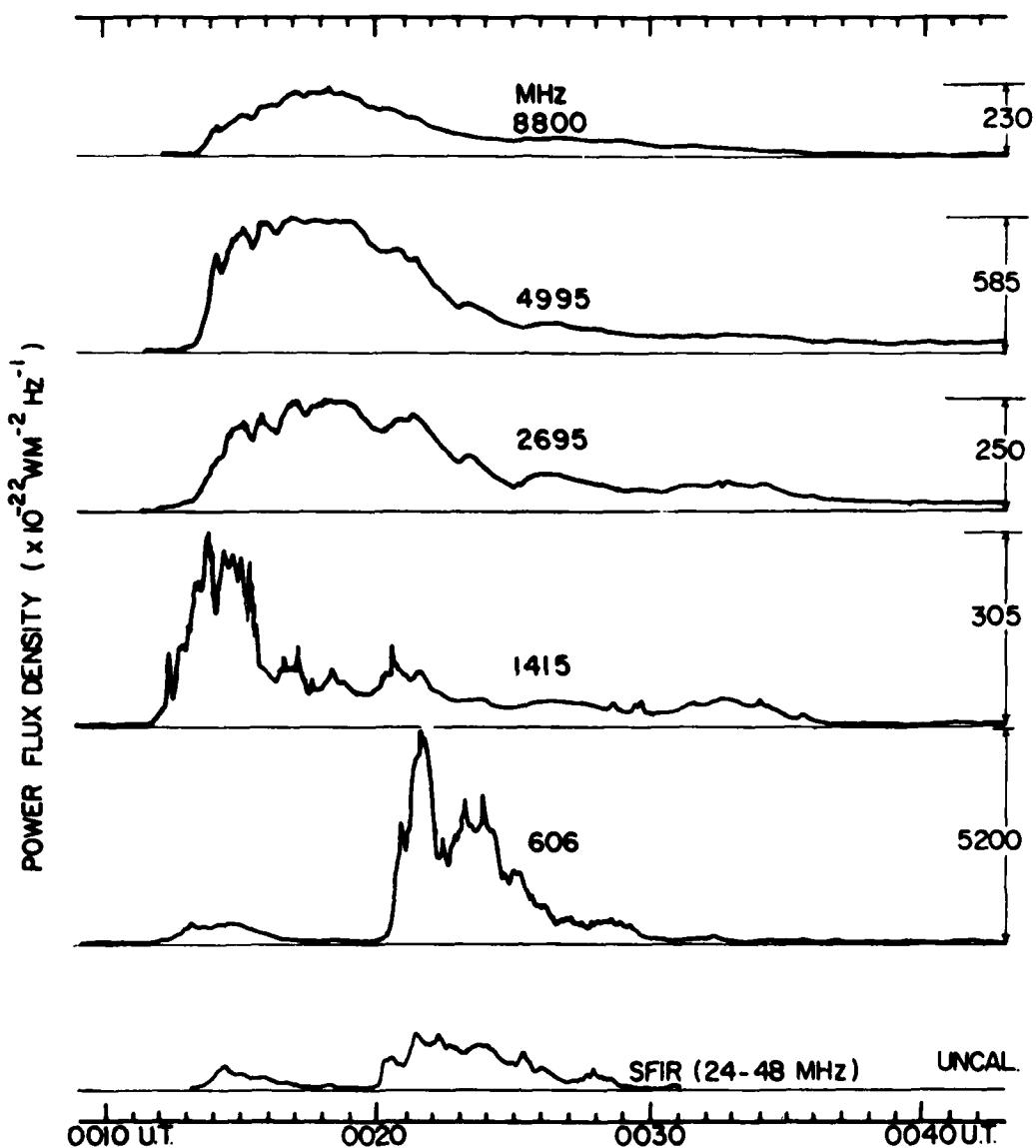




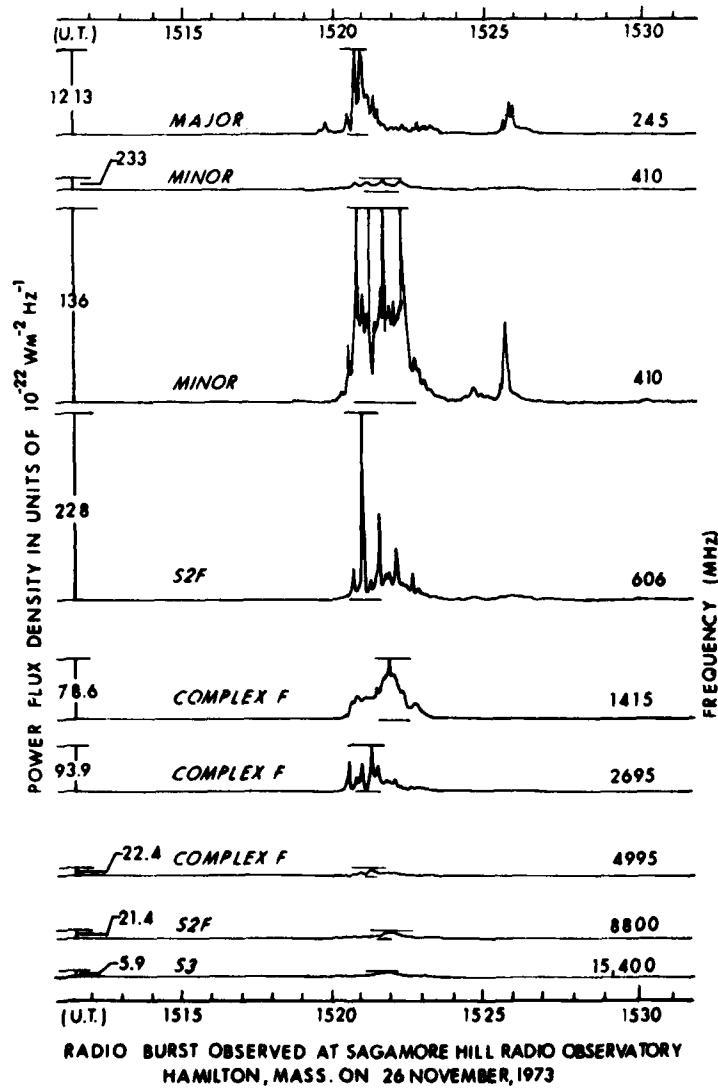


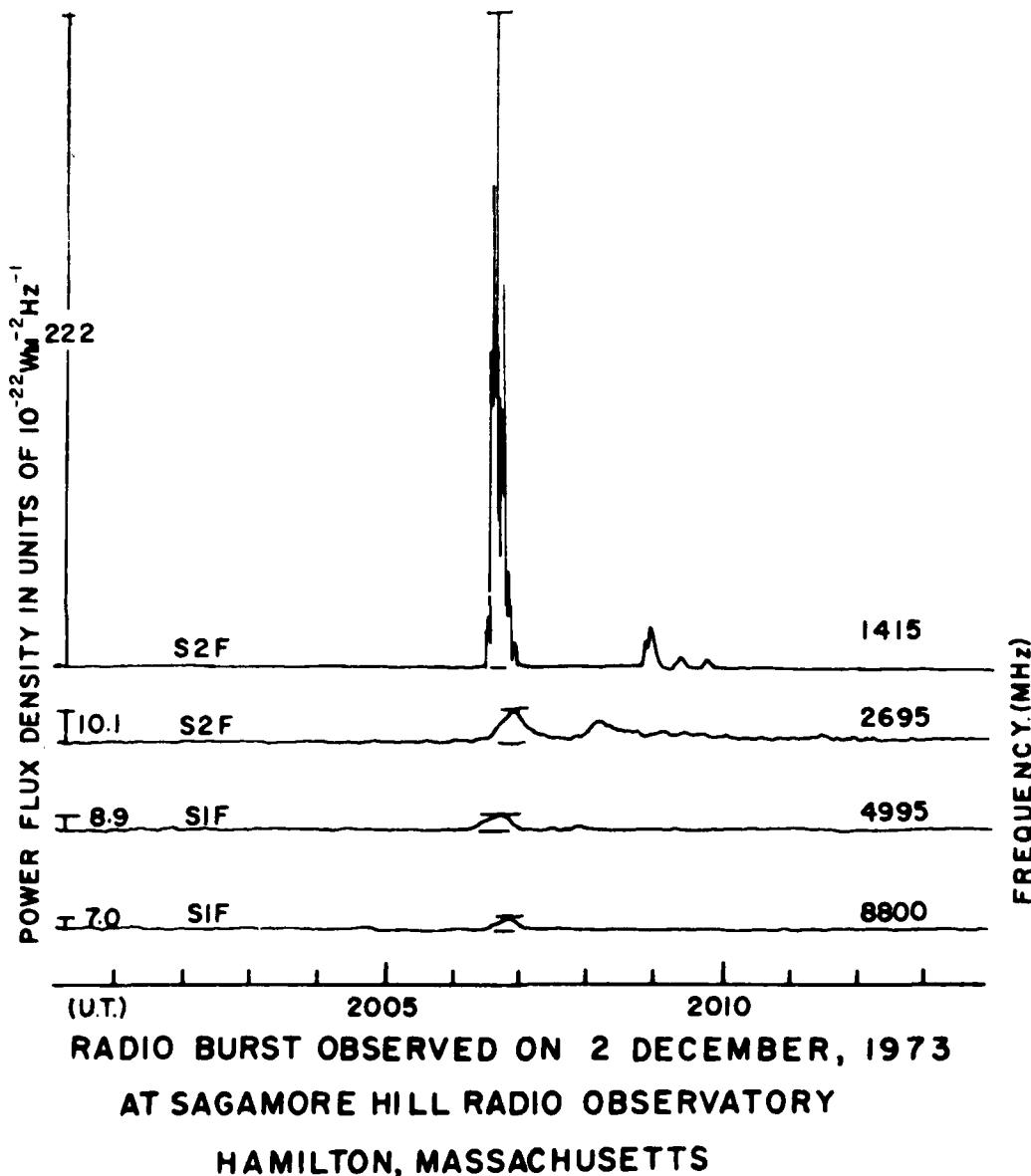
RADIO BURST, 7 SEPTEMBER, 1973 - SAGAMORE HILL OBSERVATORY AT HAMILTON, MASSACHUSETTS



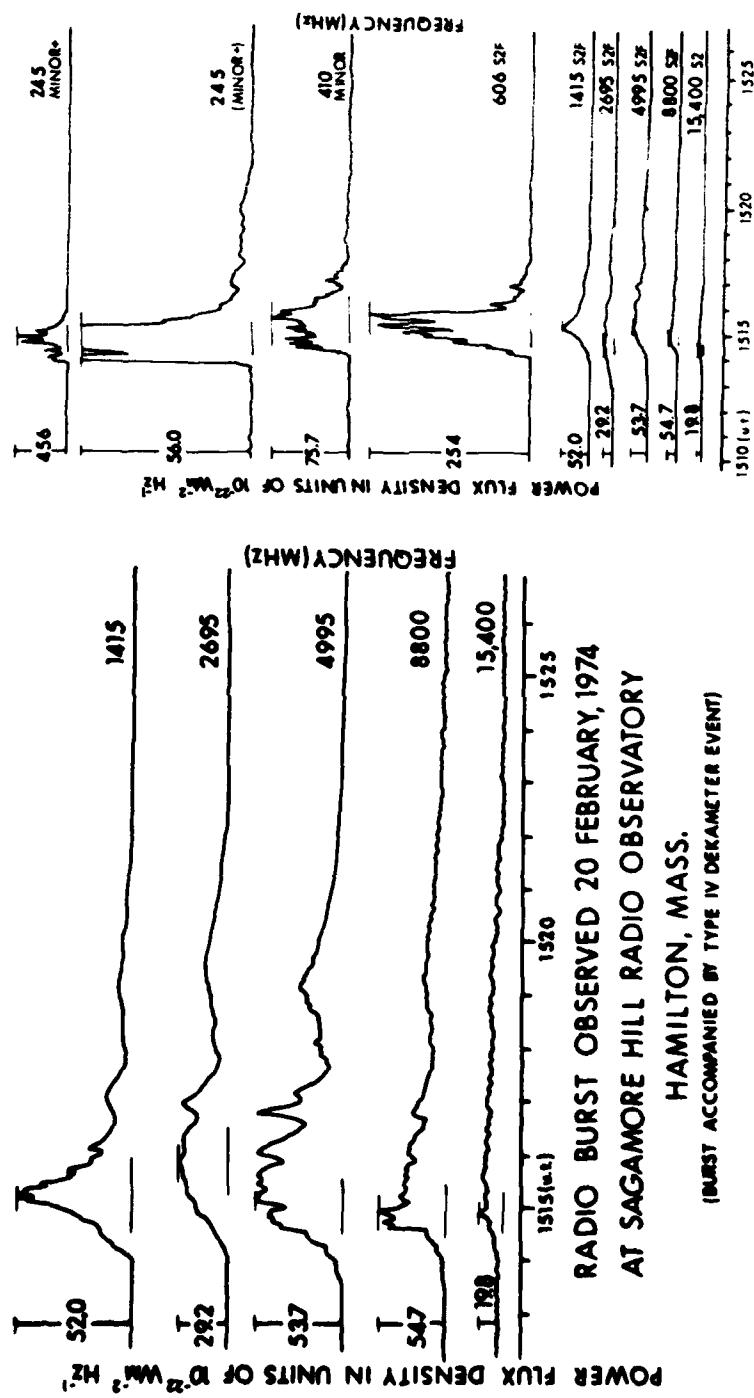


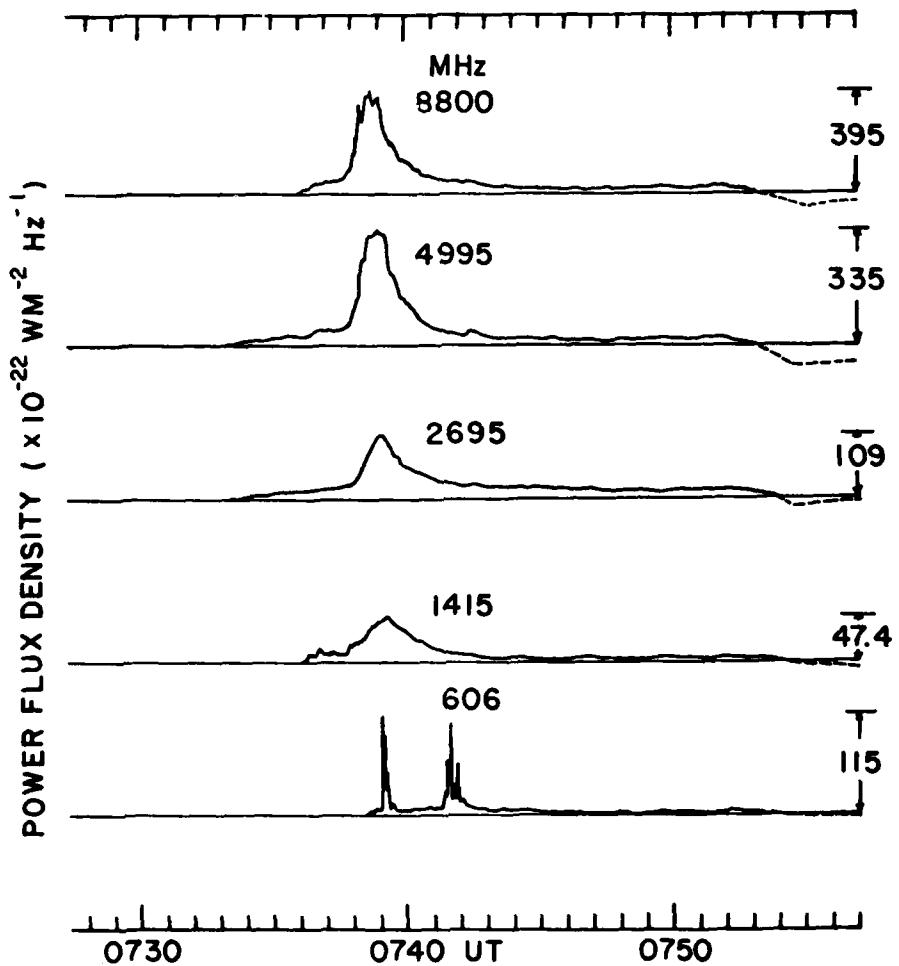
SIMPLE 2F & A GREAT RADIO BURST OBSERVED ON
03 NOVEMBER 1973, AT MANILA OBSERVATORY, R.P.

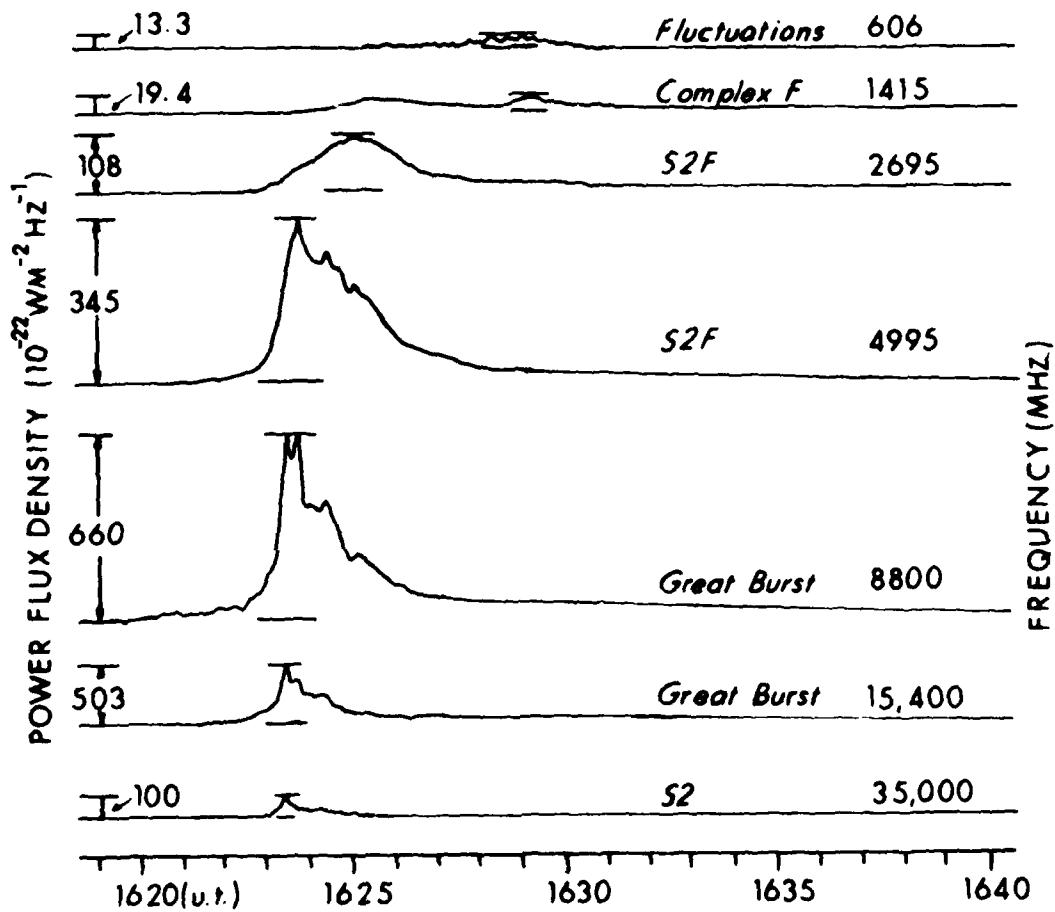




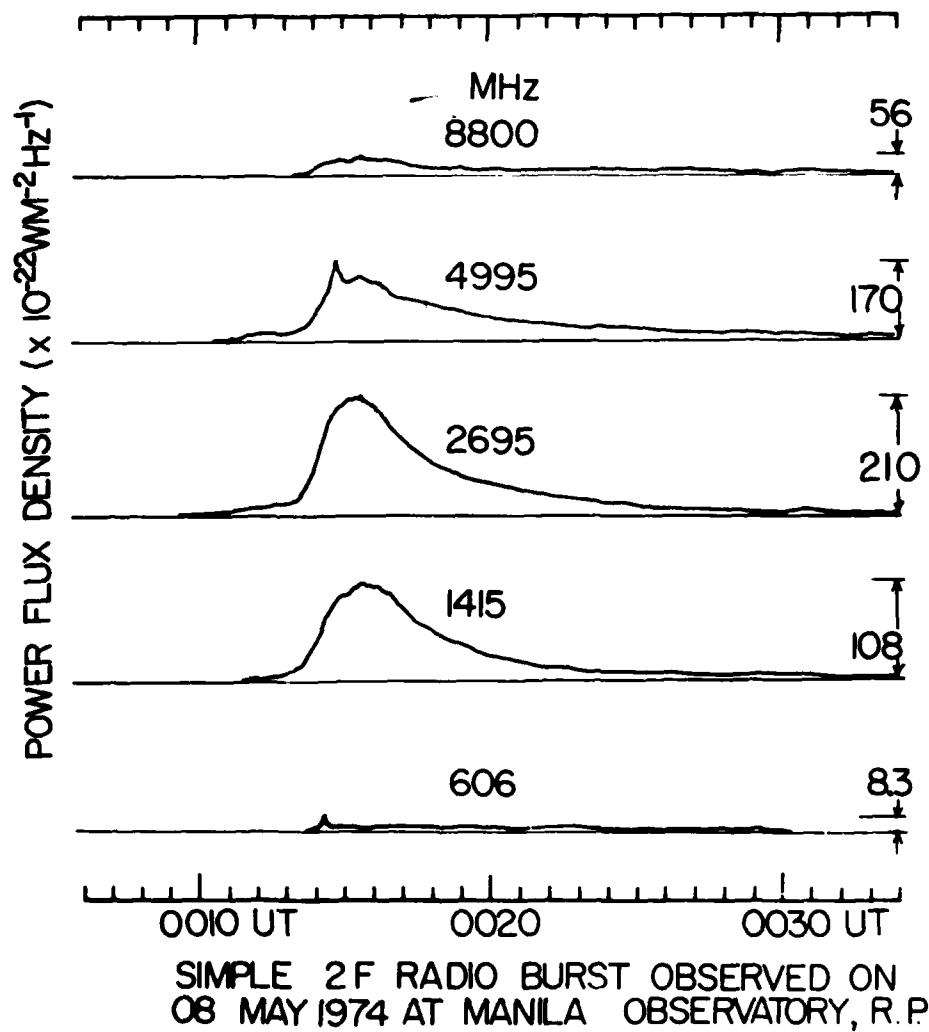
**Solar Radio Bursts
1974**

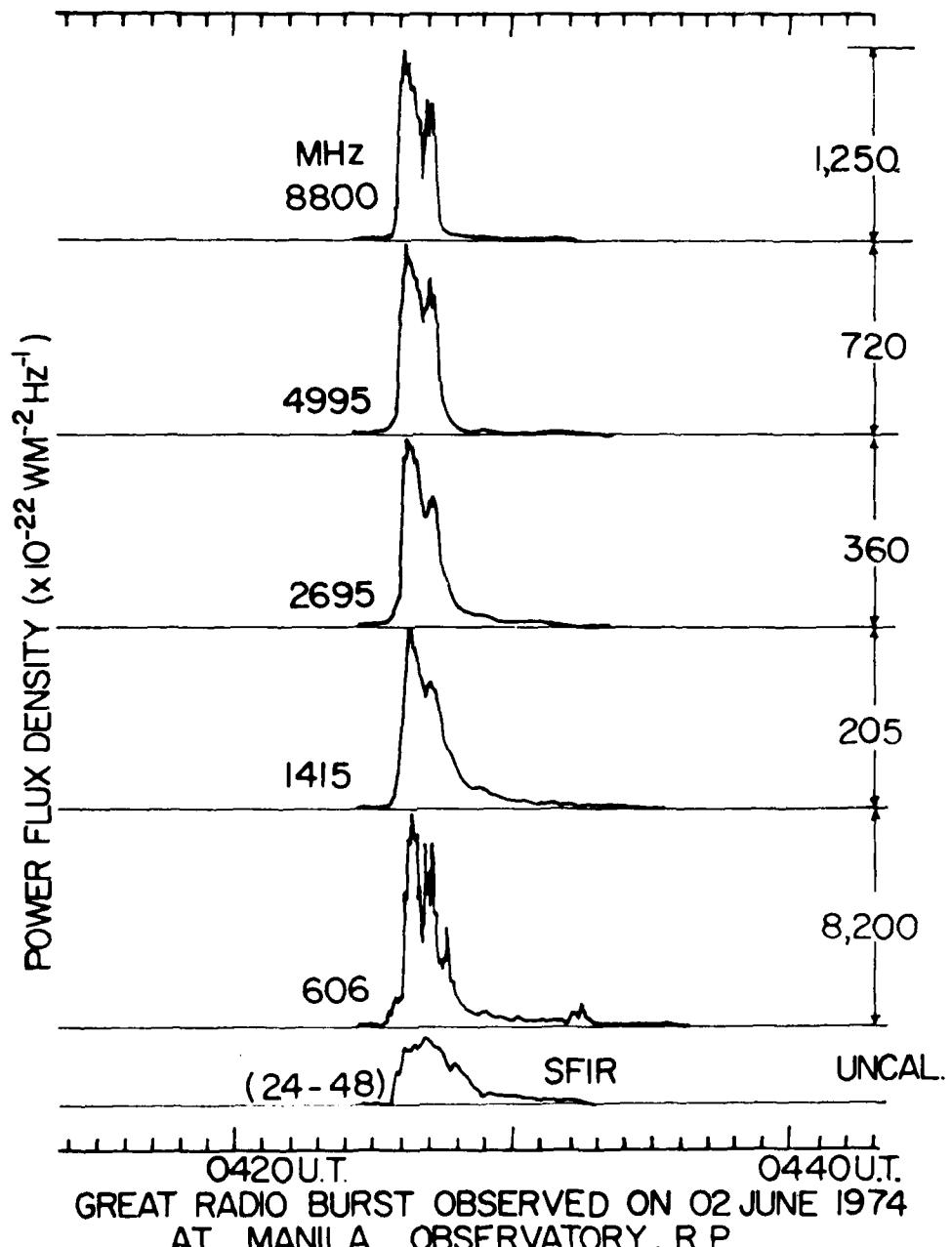


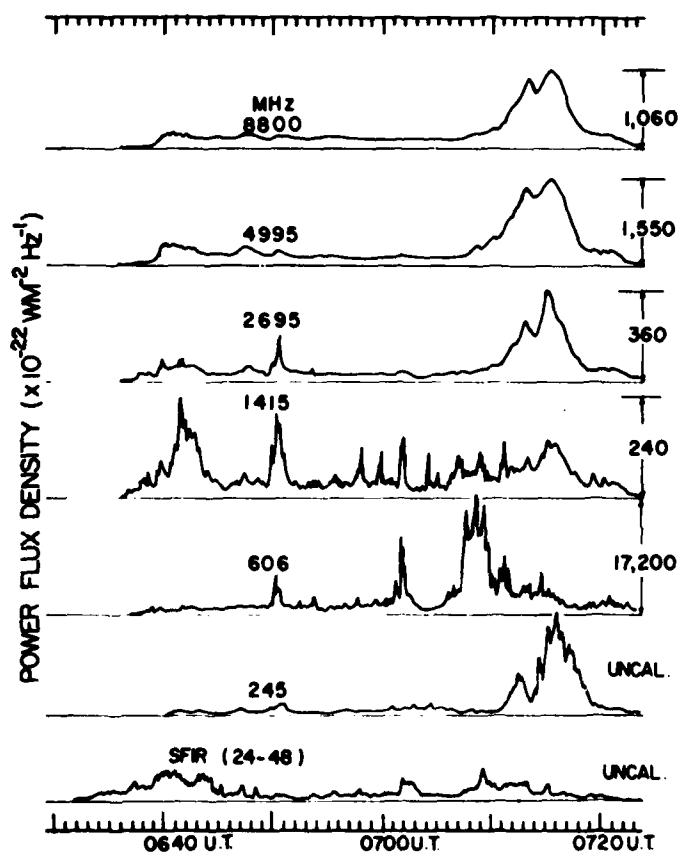




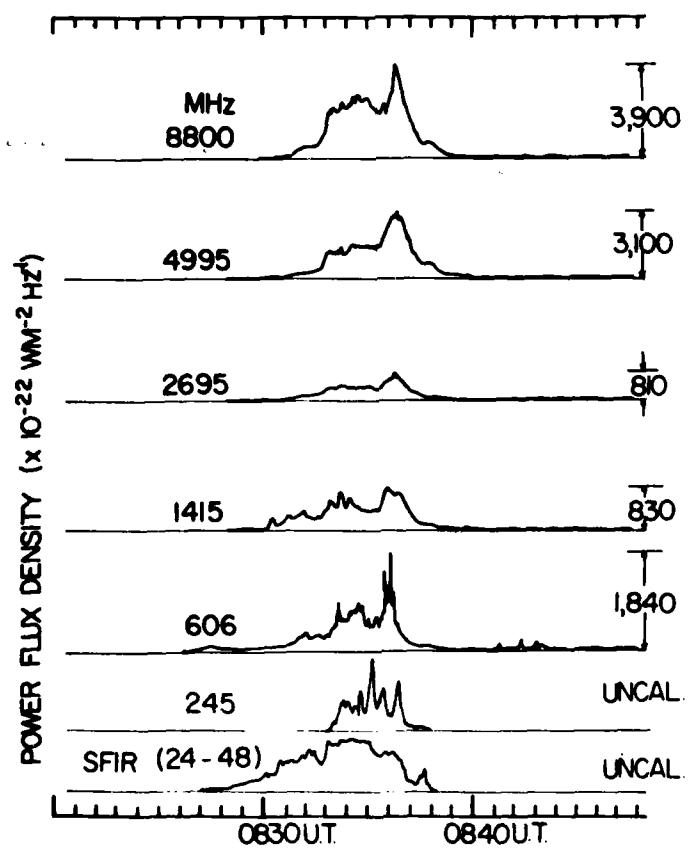
RADIO BURST OBSERVED 16 APRIL, 1974
SAGAMORE HILL RADIO OBSERVATORY
HAMILTON, MASS.



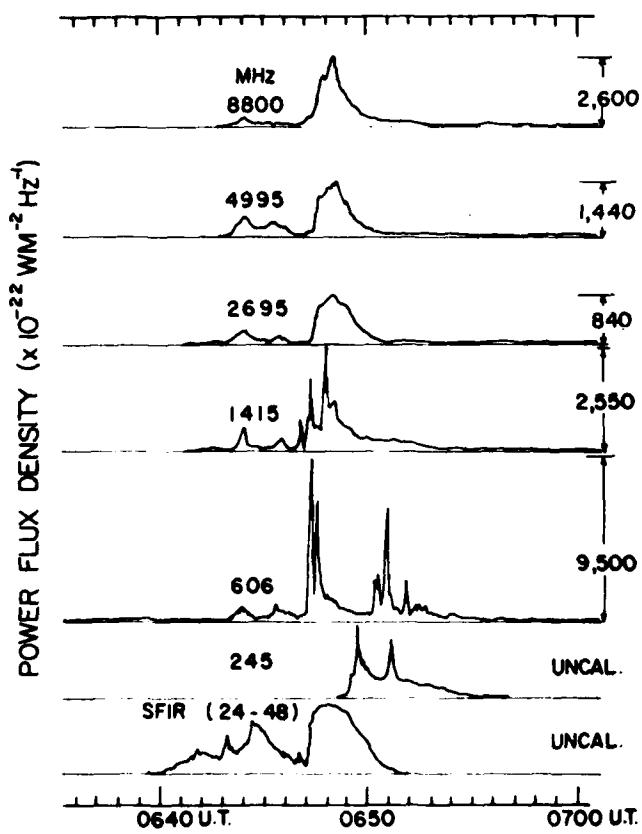




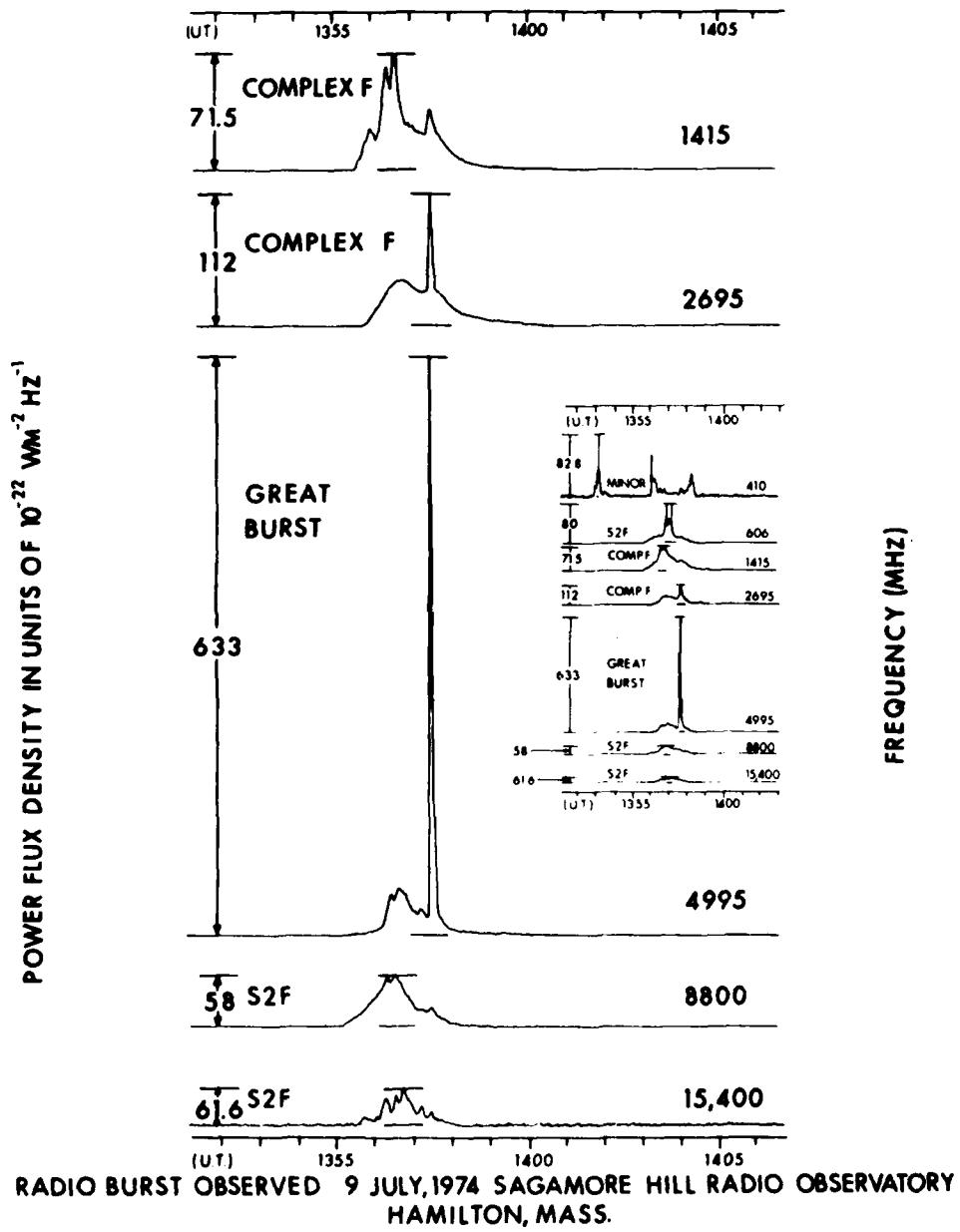
GREAT RADIO BURST OBSERVED ON 02 JULY 1974
AT MANILA OBSERVATORY, R.P.

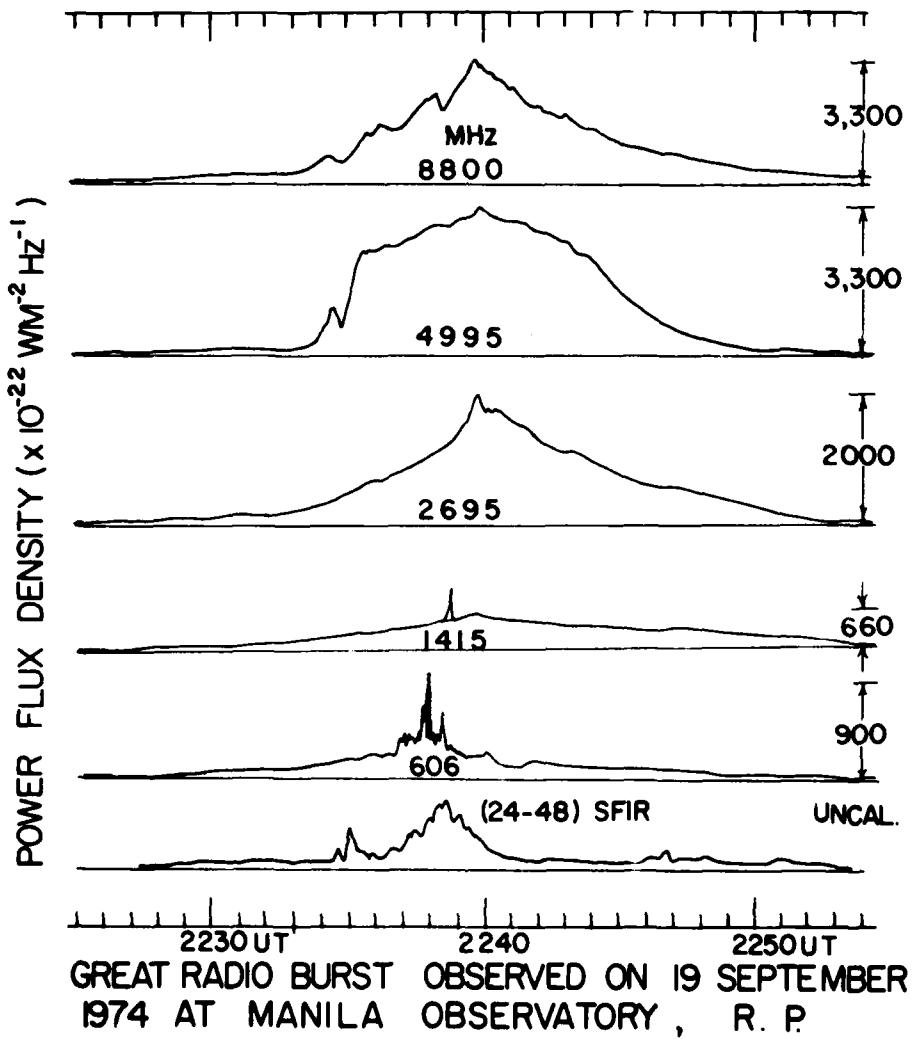


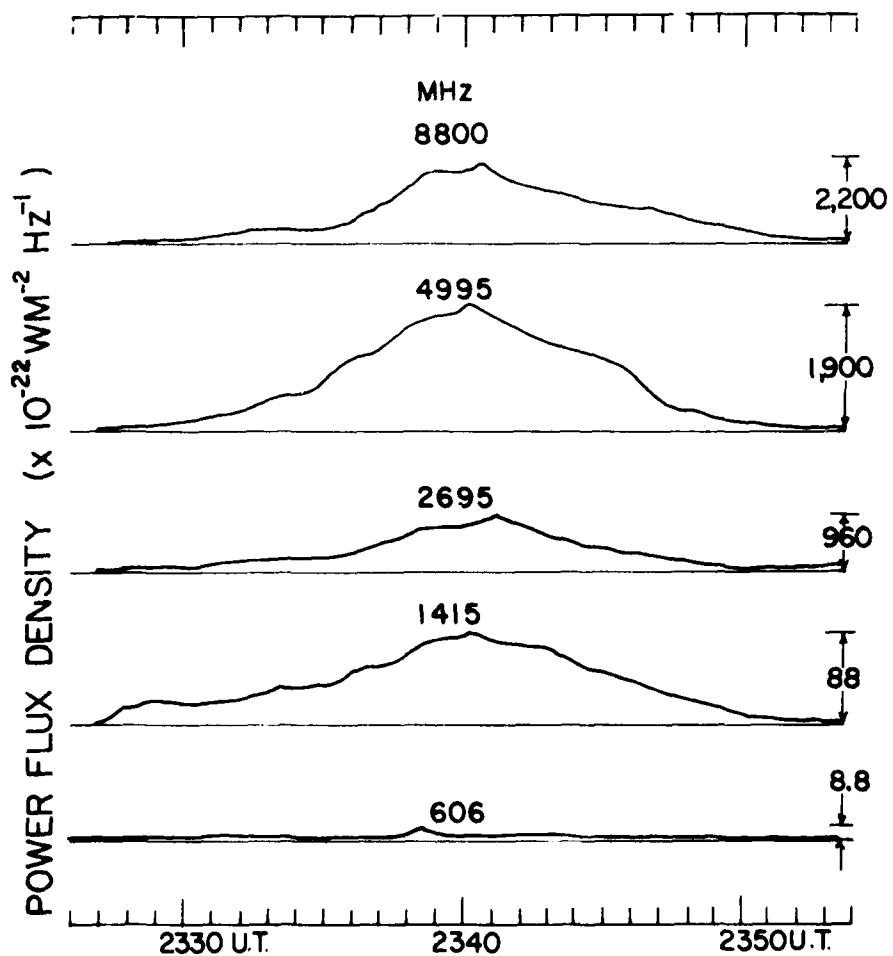
GREAT RADIO BURST OBSERVED ON 03 JULY 1974
AT MANILA OBSERVATORY, R.P.



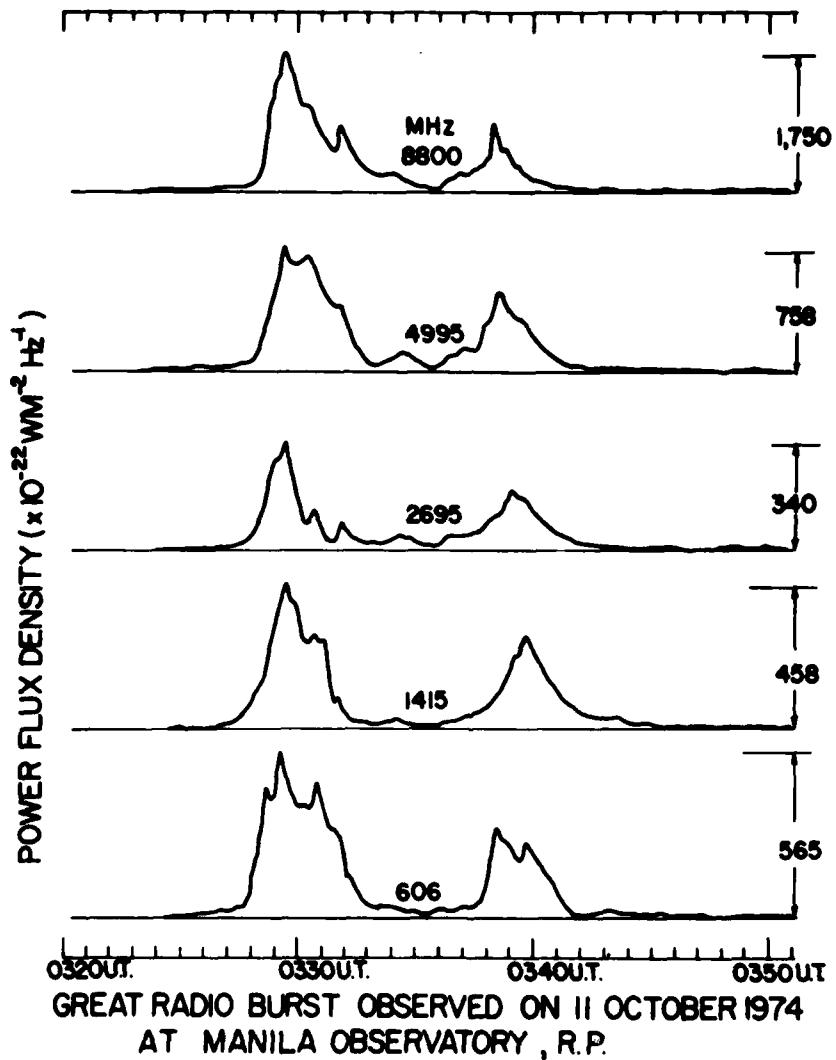
GREAT RADIO BURST OBSERVED ON 04 JULY 1974
AT MANILA OBSERVATORY, R.P.

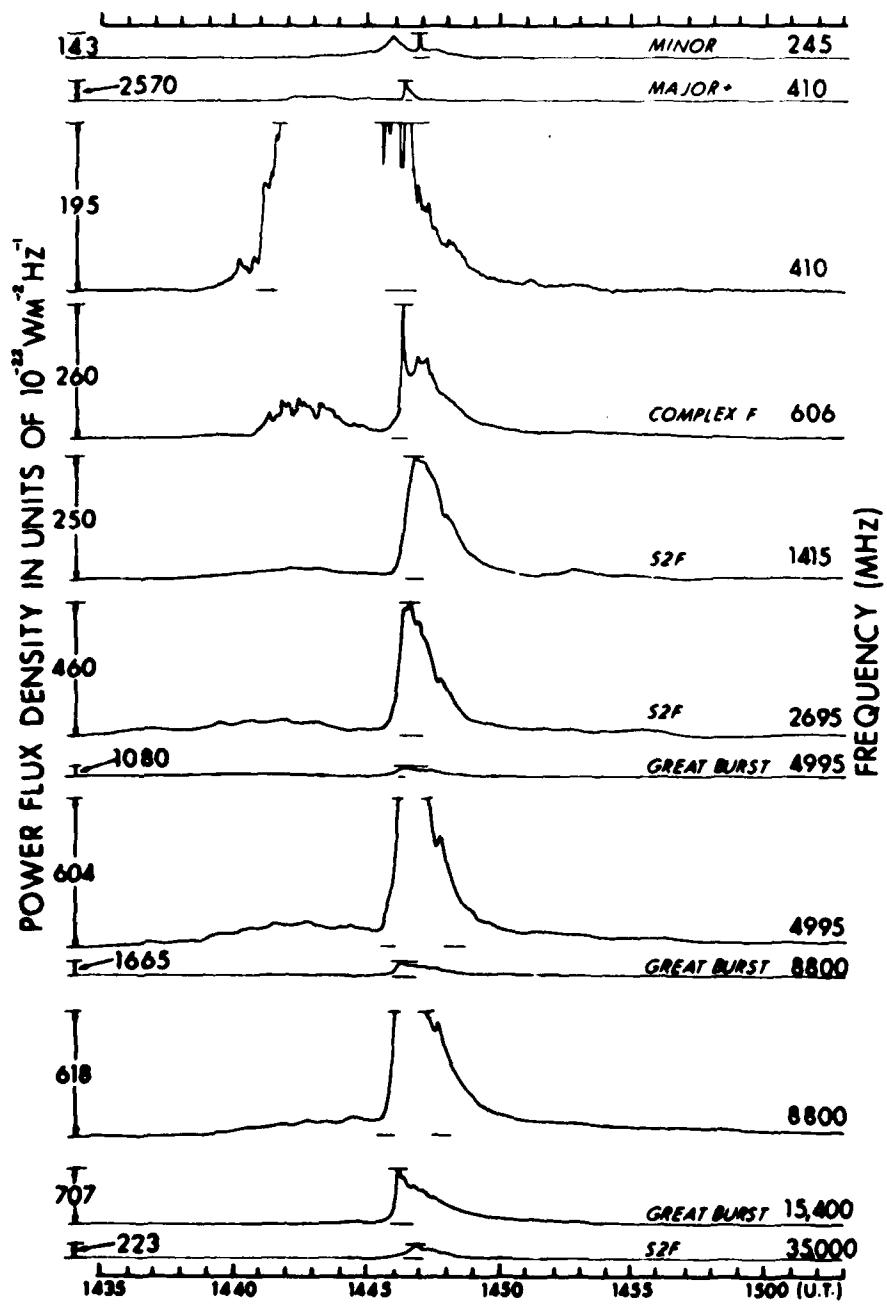




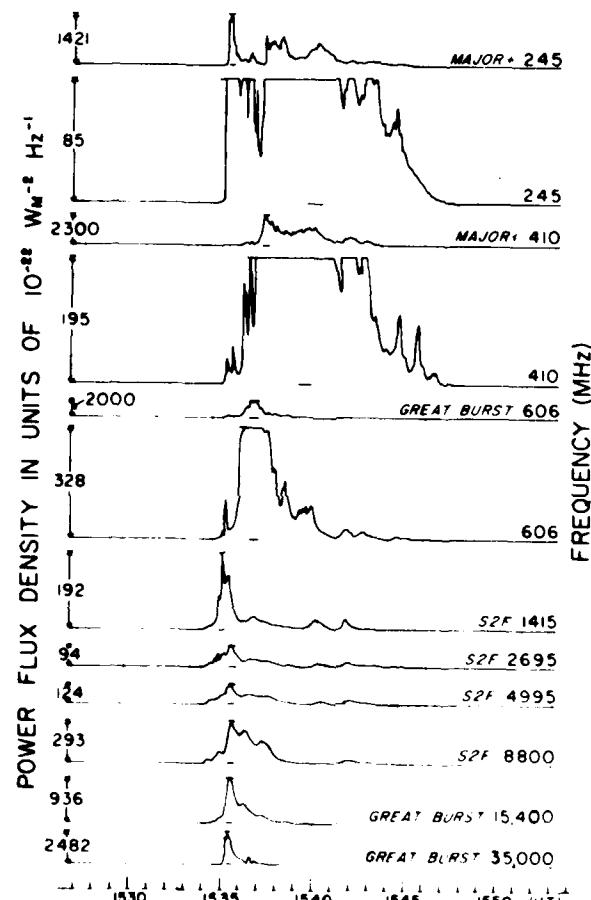


GREAT RADIO BURST OBSERVED ON 22 SEPTEMBER 1974 AT MANILA OBSERVATORY, R.P.

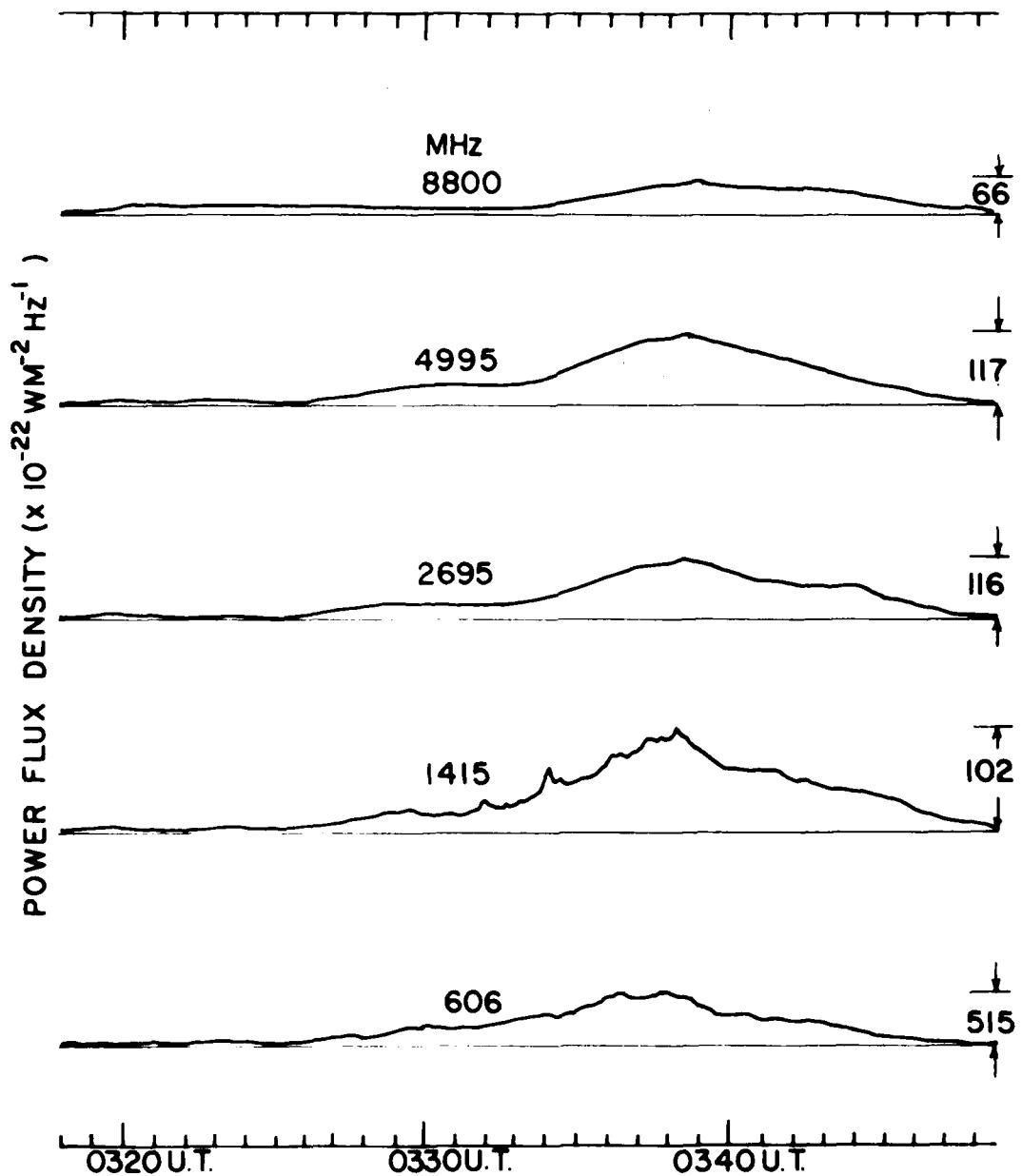




RADIO BURST OBSERVED 11 OCTOBER, 1974
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.



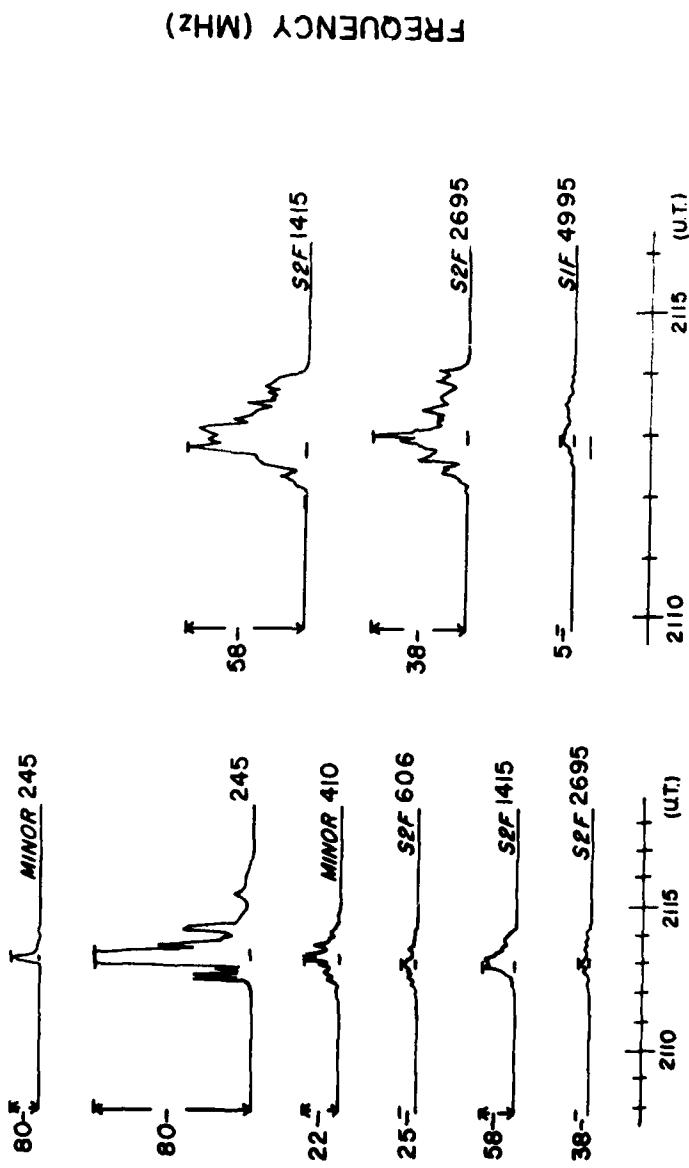
RADIO BURST OBSERVED 5 NOVEMBER, 1974
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.



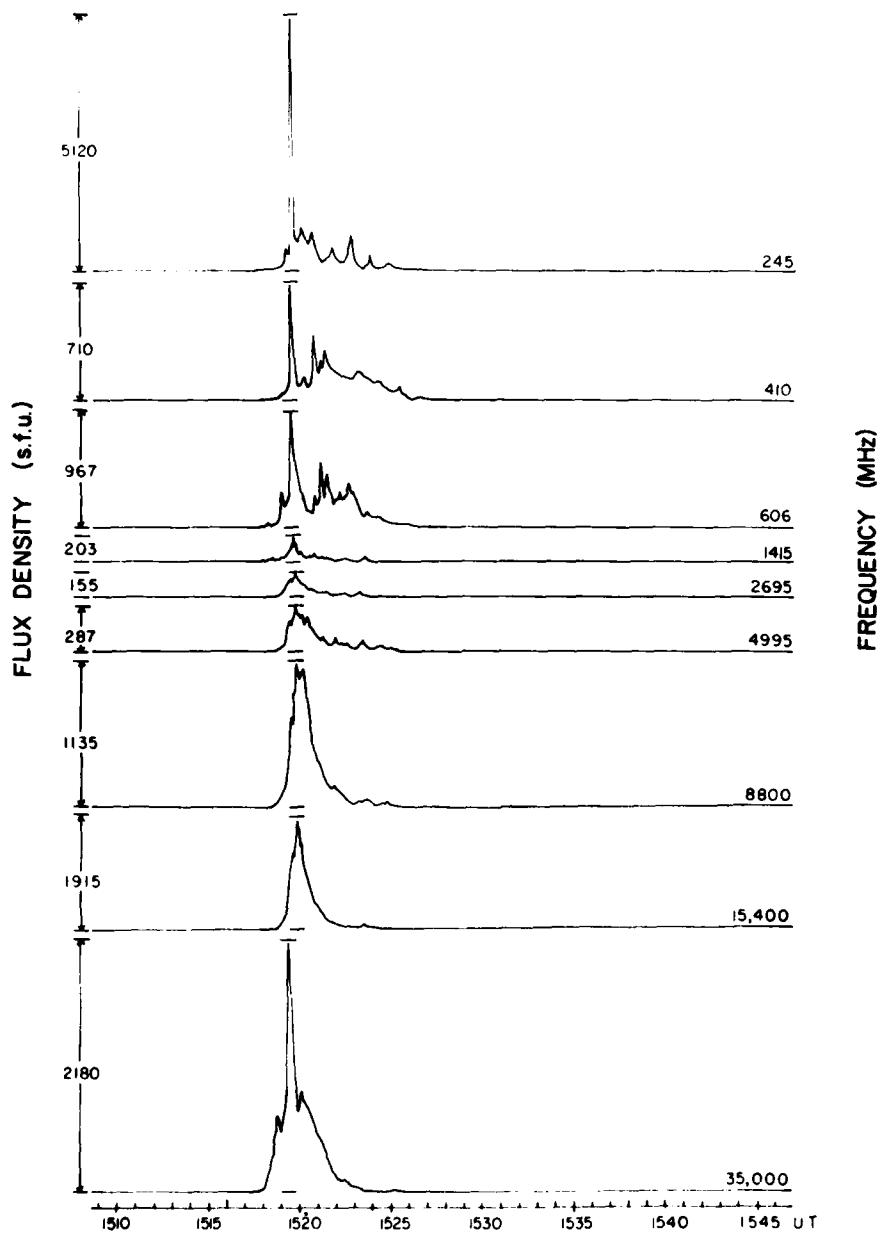
SIMPLE 2F & A GREAT RADIO BURST OBSERVED
ON NOVEMBER 06, 1974 AT MANILA OB-
SERVATORY, R.P.

~~RECORDED PAGE BLANK-NOT FILMED~~

**Solar Radio Bursts
1975**

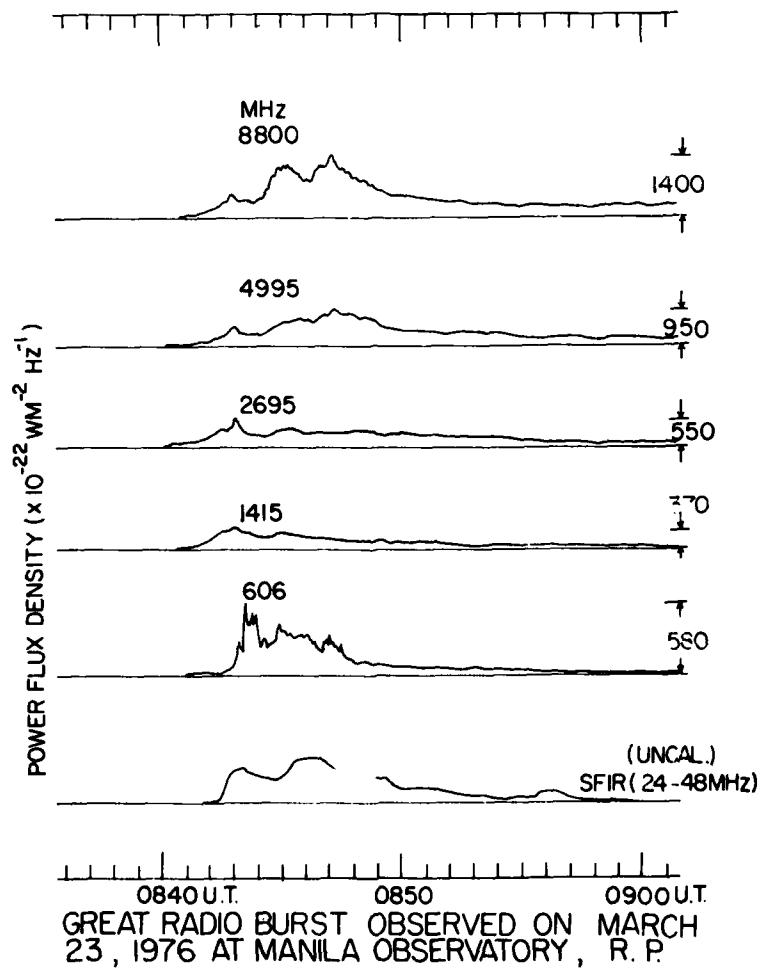


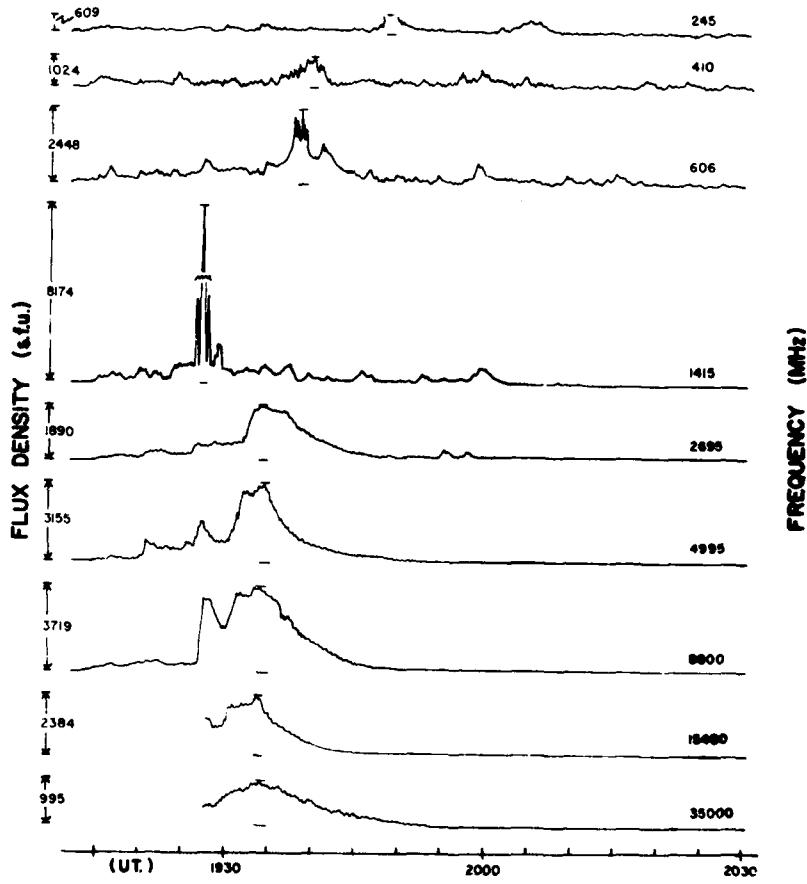
RADIO BURST OBSERVED 9 JANUARY, 1975
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.



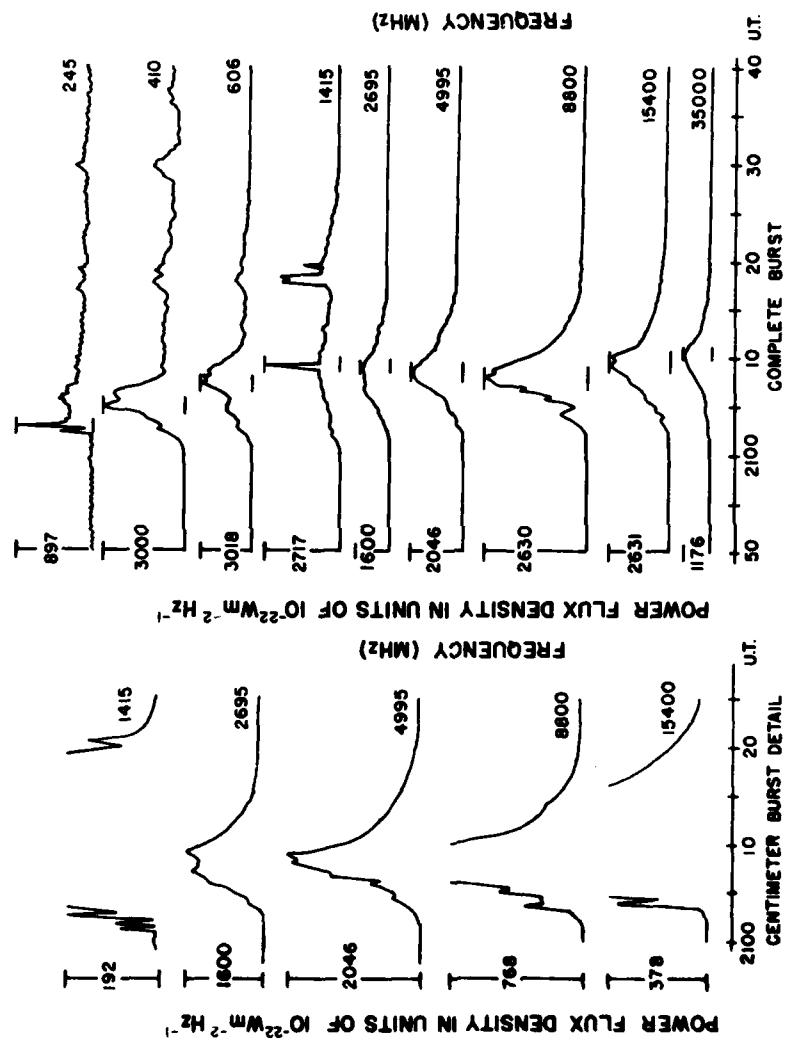
GREAT BURST OBSERVED 21 AUGUST 1975, AT
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

**Solar Radio Bursts
1976**





GREAT BURST OBSERVED 28 MAR. 1976 AT
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

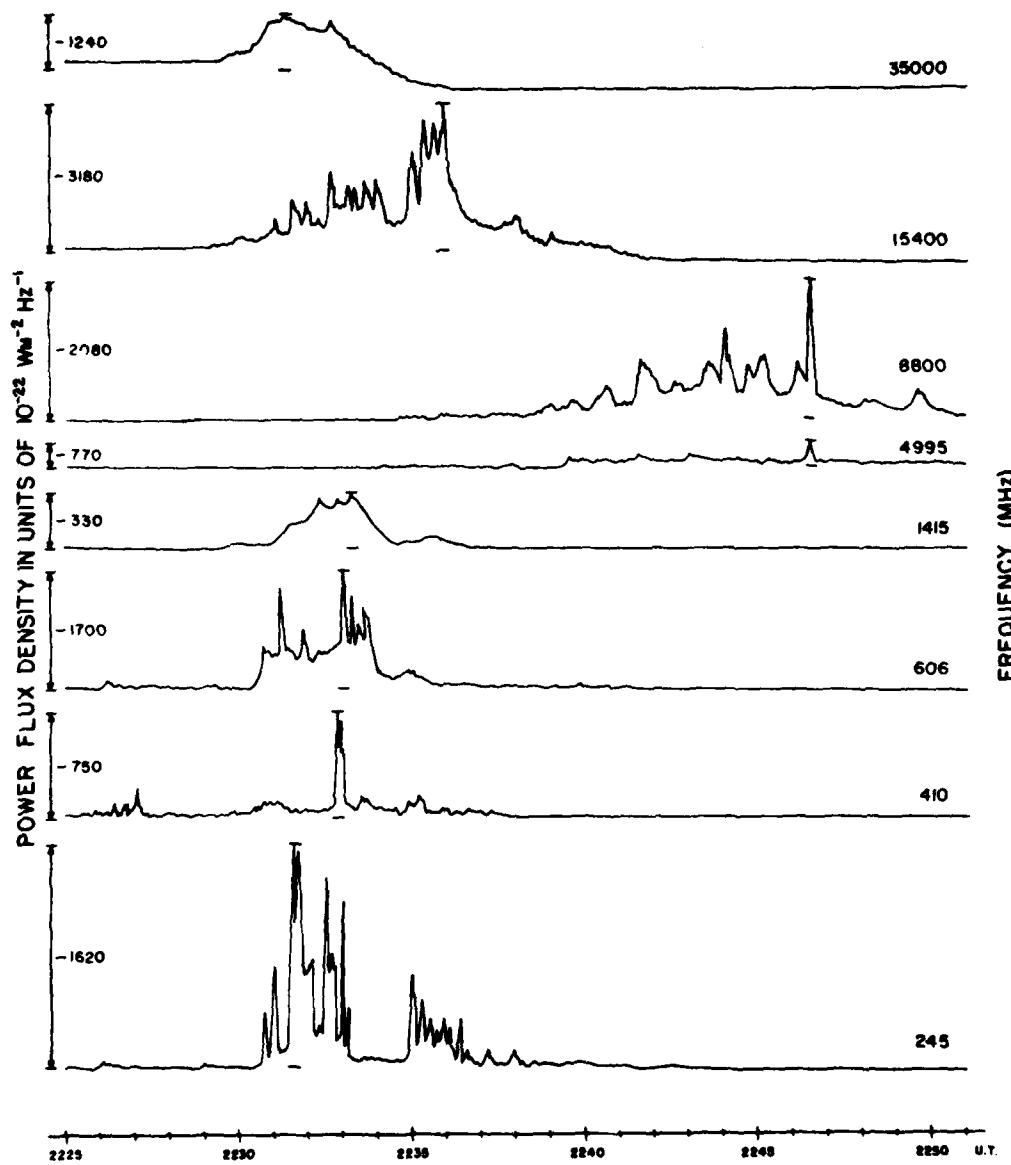


GREAT BURST OBSERVED ON 30 APR 1976
AT SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

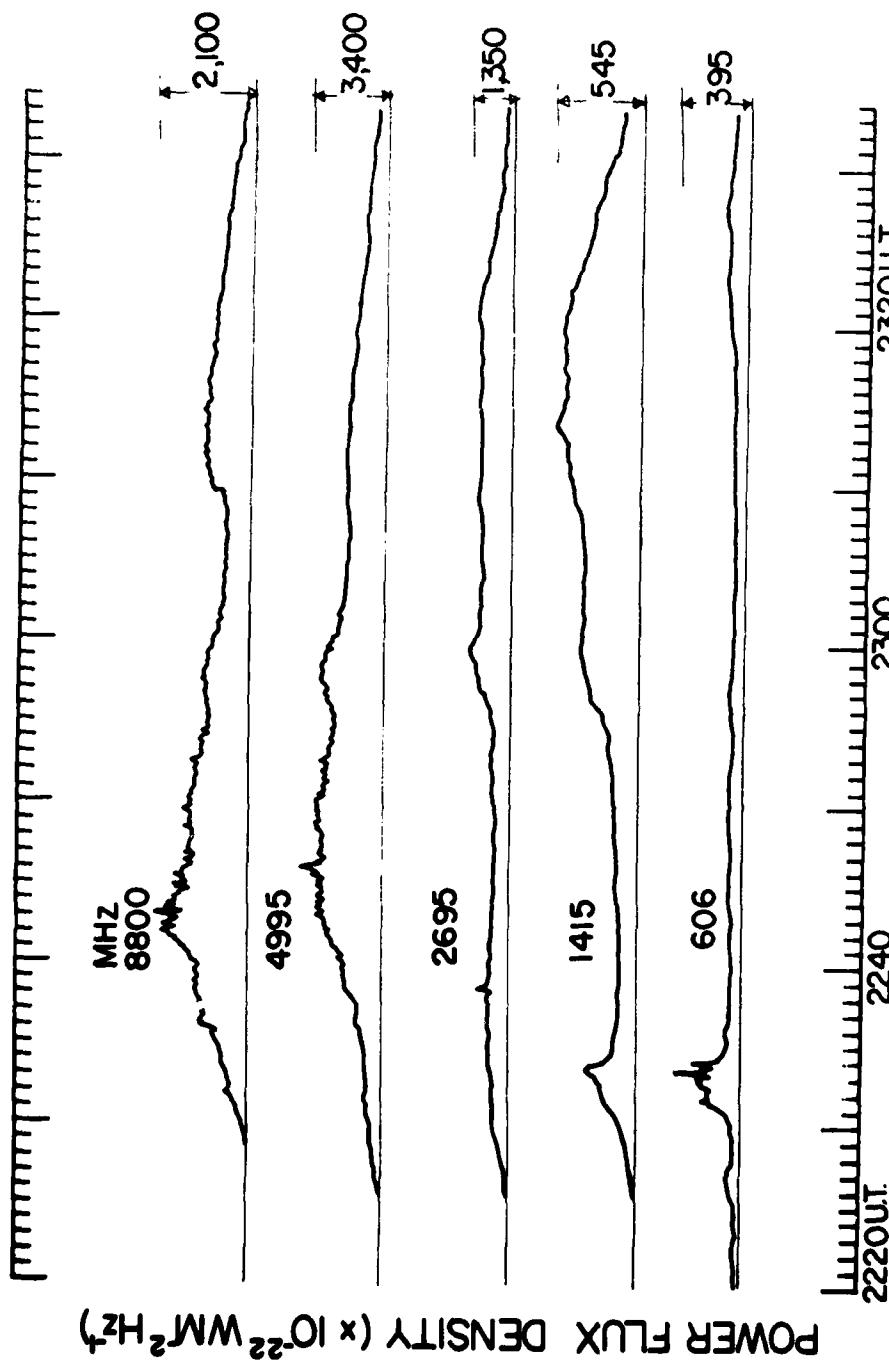
~~RECORDED PAGE BLANK-NOT FILMED~~

**Solar Radio Bursts
1977**

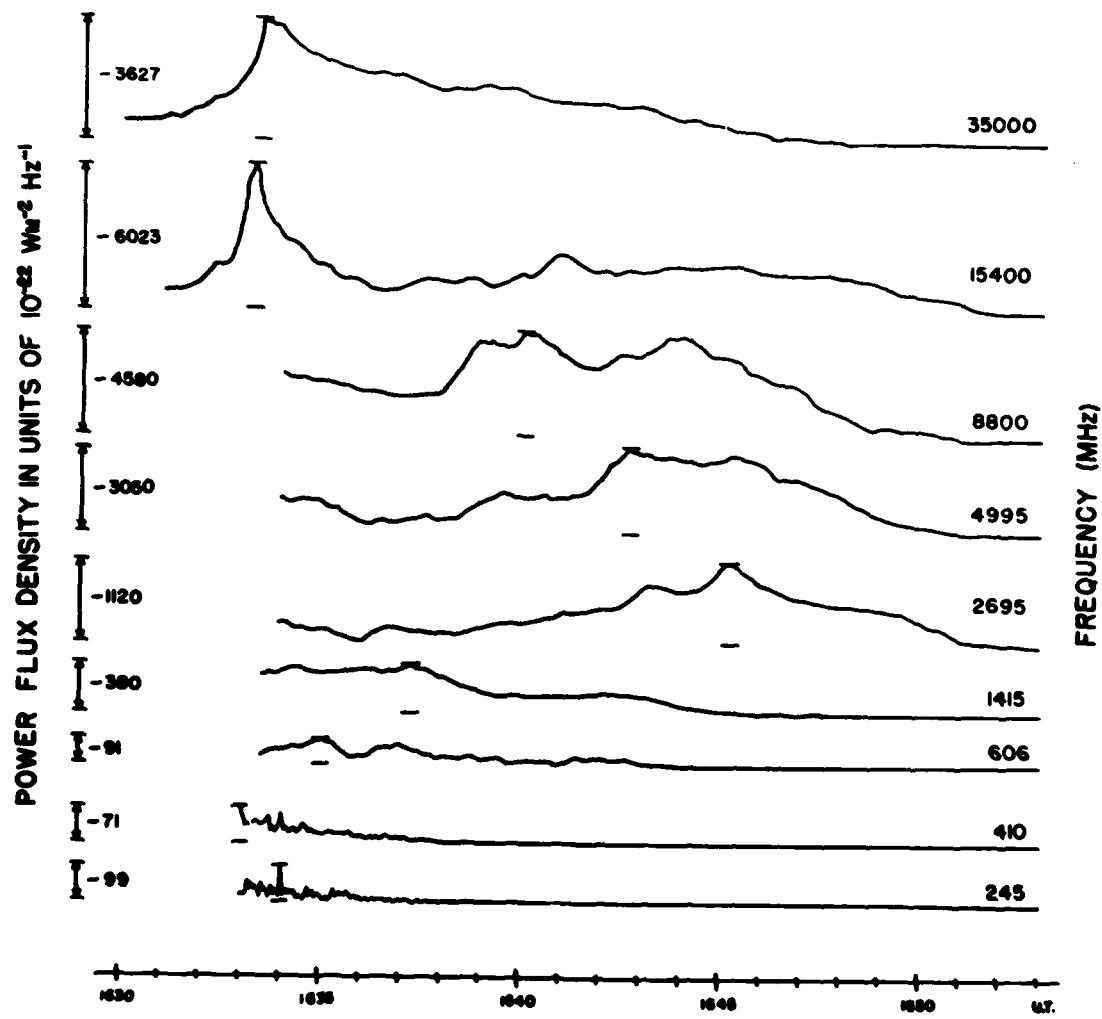
PRECEDING PAGE BLANK-NOT FILMED



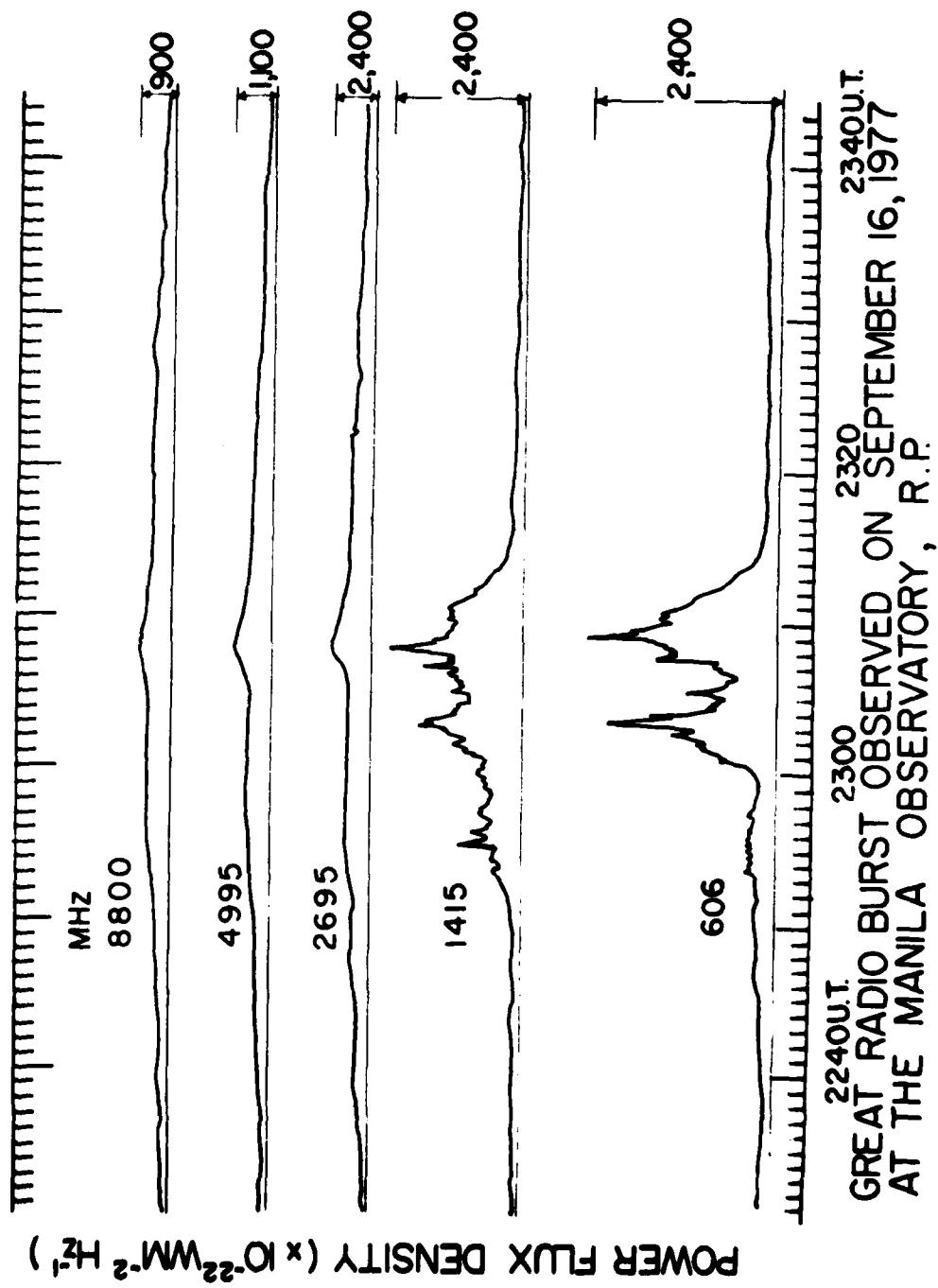
GREAT RADIO BURST OBSERVED 7 SEPTEMBER 1977
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

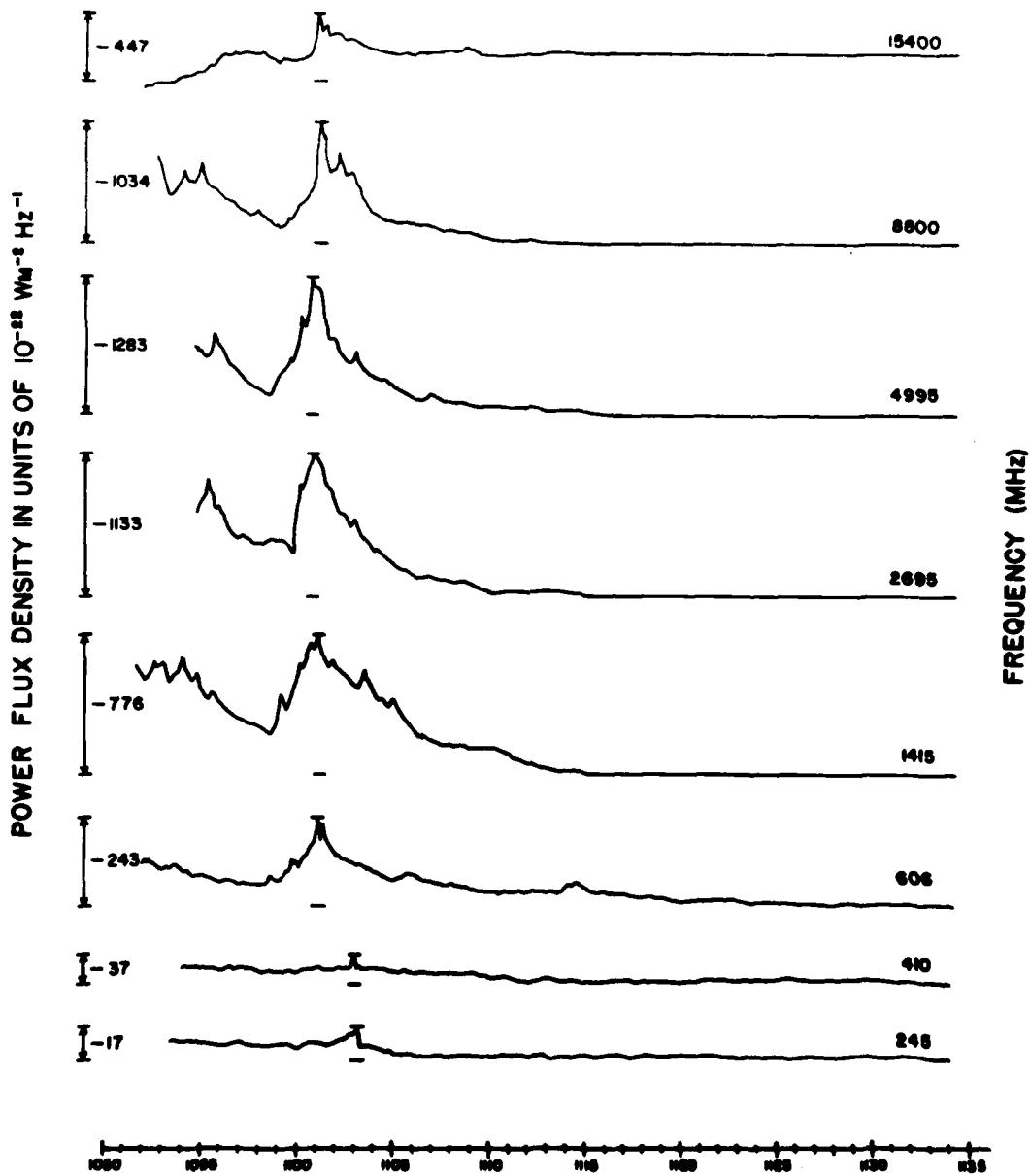


GREAT RADIO BURST OBSERVED ON SEPTEMBER 07, 1977
AT THE MANILA OBSERVATORY, R.P.



**GREAT RADIO BURST OBSERVED 9 SEPTEMBER 1977
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.**





GREAT RADIO BURST OBSERVED 19 SEPTEMBER 1977
SAGAMORE HILL RADIO OBSERVATORY, HAMILTON, MASS.

